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NORTH CAROLINA GEOLOGICAL SURVEY

JOSEPH HYDE PRATT, State Geologist.

BIENNIAL REPORT

OF THE

STATE GEOLOGIST

1905-1906

RALEIGH
E. M. Uzzell & Co., State Printers and Binders
1907

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1907

GEOLOGICAL BOARD.

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Hugh MacRae	Wilmington.
Frank Wood	Edenton.

Joseph Hyde Pratt, State Geologist	Chapel Hill.

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LETTER OF TRANSMITTAL.

CHAPEL HILL, N. C., January 1, 1907.

To His Excellency, GOVERNOR R. B. GLENN.

SIR:—I herewith submit the Biennial Report of the North Carolina Geological and Economic Survey for the fiscal years 1905 and 1906. It includes a brief outline of the work accomplished by the Survey, referring for more detailed information to the reports that have been published. Certain special reports, however, are given here in their entirety, as being the most practicable place to publish them. Suggestions have been made regarding further legislation in connection with the work of the Survey, and I beg to call your particular attention to these.

At the end of the report is a statement regarding the expenditures of the Survey, showing approximately the cost of each investigation taken up.

Yours obediently,
JOSEPH HYDE PRATT,
State Geologist.

BIENNIAL REPORT

OF THE

STATE GEOLOGIST

ON THE OPERATIONS OF THE NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY FOR THE TWO YEARS ENDING NOVEMBER 30, 1906.

BY JOSEPH HYDE PRATT, STATE GEOLOGIST.

INTRODUCTION.

The North Carolina Geological and Economic Survey was authorized by an act of the General Assembly of 1905, as recorded in Chapter 542 of the Public Laws of North Carolina, 1905. On account of the enormous amount of work that this Department is called upon to do, and the very varied investigations that it has made and is still carrying on, it is impossible to give in this report more than a brief outline of the work accomplished and refer to the published reports which give in detail the results of all these investigations.

The objects of this Survey, as stated in the act creating it, are to include:

1. "An examination of the mineral, forest, fish and other material resources of the State.

2. "Examination of the geological formations of the State, with reference to their economic products.

3. "An examination of the road-building materials and the best method of utilizing same.

4. "An examination and classification of the soils, the forests and other physical features of the State, with special reference to their bearing upon the occupation of the people.

5. "An examination of the streams and water-powers of the State, with special reference to the development for manufacturing enterprises and the preservation of the sources of these streams through the protection of the forests.

6. "The consideration of such other scientific and economic problems as in the judgment of the Geological Board shall be deemed of value to the people of the State.

7. "The preparation of such reports, illustrations and maps as may be deemed necessary in placing the results of these investigations before the public.

8. "An examination of the water supplies of the State, with special reference to the sinking of deep or artesian wells.

9. "The State Geologist, with the approval of the Geological Board, is hereby authorized to arrange for and accept such aid and coöperation from the several United States Government Bureaus and other sources as may assist in completing the topographic surveys of the State and in carrying out other provisions of this chapter."

As is seen from the above, the objects of the Survey include practically everything related to natural resources in which the State is in any way interested. Some are at the present time of much more importance than others, and in arranging the work consideration has been given to the more important lines of work. Thus, special investigations have been made relating to the artesian water supply in eastern North Carolina; construction and maintenance of public roads throughout the whole State; to the condition of the fish and oyster industries; to the value of the State's supply of building stones; to the need and value to North Carolina of the establishment of the Appalachian Forest Reserve; and to the metallurgical treatment and utilization of the low-grade gold ores.

While the above have received the greater attention, other investigations have also been undertaken relating to the occurrence and commercial value of the copper ores, mica, tin and monazite; the value of the forest lands belonging to the State; the magnetic variations, etc. Certain investigations that had been begun and nearly completed by the former Survey have been finished, and the results in some instances have been published.

MINERAL AND GEOLOGICAL INVESTIGATIONS.

MINERAL INVESTIGATIONS.

In this connection the Survey has examined regarding the production of each mineral that has been mined or quarried in the State during each year, and these results have been published in a series of reports on the Mining Industry of the State during 1904 and 1905, known as Economic Papers Nos. 9 and 11. These Economic

Papers give not only the statistics of the actual production of these minerals, but also descriptions of new mineral localities, and calls particular attention to those that are apparently of economic importance. These statistics have now been collected for six years, and the past year has shown a decided increase in the value of the mineral products of the State.

The statistics are arranged so as to show the value and quantity of each mineral produced, and also the quantity and value of all the mineral products obtained from each county. There are certain minerals, as mica, monazite and zircon, for which North Carolina is especially noted, and she produces more of these than all the other States in the Union. The State's mineral products of greatest value are clay and building stones, and although these are being developed more and more each year, they are far from being produced as extensively as the quantity and quality of these products would warrant.

The field work that has been carried on during the past two years has covered a wide area and has included the investigation of many minerals and ores.

Gold.—The gold deposits, especially the low-grade ores, have been thoroughly investigated and the results are being prepared for publication as an Economic Paper on Further Investigations of the Gold Deposits of North Carolina. Therefore, only a short synopsis of this work, which has been done by Messrs. A. A. Steel, F. B. Laney and the State Geologist, is given here.

During the field seasons all of the working gold mines of the State, regarding which creditable reports could be obtained, have been examined; and also many new localities, especially those where the ore is of low grade but in large quantity. Certain concentrating machines have been examined, with special reference to their adaptability to the saprolitic rocks that carry a small amount of fine gold. One of these, known as the Modern Pulverizing and Concentrating Machine, has with modifications been operated successfully at a number of localities, as at the Shuford mine near Edith, Catawba County, and at the old Lafflin mine near Cox, Randolph County.

This investigation of the gold deposits of North Carolina has shown conclusively that one cause of failure of many of the gold mines has been the inefficiency of those placed in charge of the property. Most of the better gold mines in the State will contain low-grade ore, and a careful, economical and conservative management is absolutely essential to the successful operation of the mine. Also, it will be necessary to carry on the operations on a very large scale, so as to be able to treat a large tonnage of ore. In order to do this it is necessary before commencing mill operations to have blocked out a body of ore that will be equal to at least a two years' supply for the mill. Unfortunately, in many instances, there has been a very large expenditure of capital in installing a stamp mill, concentrating plant, or some other machinery, for treatment of the ore before there has been any large body of ore definitely blocked out. The result in most cases has been the closing down of the property from lack of capital to develop it.

Copper.—The copper deposits are being thoroughly investigated, and the field work on this should be completed early in 1907. The results of the investigation will be published in a bulletin on the Copper Deposits of the State. This work has included a thorough investigation of the Swain County copper deposits on Hazel Creek by Mr. F. B. Laney. In order to do this work satisfactorily it was necessary to make a detailed survey of about 75 square miles of territory, including all the Eagle Creek water-shed and the greater portion of the Hazel Creek water-shed. The whole area was traversed in detail and mapped on a scale of 5 inches to the mile by Mr. Charles N. Parker, of Asheville, N. C. The territory was also studied geologically, and the work has shown that the greater portion of the area is probably barren as regards ore deposits, and that the mineralized zone is only a narrow belt extending from near Siler's Bald southwestward to near the mouth of Eagle Creek. This zone is in proximity to an igneous dike, probably of diorite, which may be the source of the ore. Part of this work has been done in coöperation with the R. E. Wood and Montvale Lumber Company.

Investigations were begun on the copper deposits in Jackson County, but only the Cullowhee mine could be studied in any detail. A detailed study was made of this mine and the relation of the ore to the rocks, and work was begun on the general structure of the region. This work will undoubtedly be of practical value by throwing light on the relations of the ores to faulting, folding and jointing. This work will be continued during the coming summer.

The Gold Hill copper deposits in Rowan County and those near Cid, Davidson County, have been investigated by Messrs. Steel and

Laney. In these investigations maps were made of the underground workings and, as far as it is possible, a comprehensive idea was obtained regarding the occurrence and origin of these copper deposits, and the results should be of large practical value in the future development and mining of these deposits and others in the vicinity.

The copper deposits in Person and Granville counties have been studied to some extent by the State Geologist, and the work in this section will be completed early in the spring.

A preliminary reconnaissance has been made of the copper deposits in Ashe and Alleghany counties, and their investigation will be completed in the early summer of 1907.

Tin.—The tin deposits of Cleveland, Gaston and Lincoln counties have been further studied by Mr. F. B. Laney and the State Geologist, and it is believed that information of practical value will be derived when the data and material collected have been thoroughly studied.

Mica.—Investigations regarding the occurrence of mica and its associated minerals have been continued during the past two field seasons by Mr. Douglas B. Sterrett and the State Geologist. Field work was carried on in Ashe, Mitchell, Yancey, Watauga, Wilkes, Lincoln, Cleveland, Rutherford, Buncombe, Jackson, Macon, and Swain counties. Nearly all of the data have now been collected for the publication of a volume on Mica and the Pegmatites of Western North Carolina. This volume will include not only a thorough discussion of the occurrence, value, distribution and quantity of mica in North Carolina, but will also take up a detailed description of the other economic minerals that are found in these pegmatitic dikes, which will include the uranium ores, which are also radium ores; of columbite and samarskite, ores of tantalum; and gem minerals.

Monazite.—The monazite regions are being investigated principally as to the minerals of economic value, besides monazite that are contained in the sands and gravels. This work is being done in connection with the black sand investigation, which is referred to beyond. This work will undoubtedly result in demonstrating that other minerals, such as magnetite, garnet, zircon, etc., can be separated commercially from these sands, thus increasing their value to the producer.

The North Carolina Survey has coöperated with the Federal Survey in a special investigation of the mineral resources of an area known as the Balsam Forest Region, which includes parts of Haywood, Jackson, and Transylvania counties. Detailed topographic and geologic work has been done, and a special report is now being prepared on the general mineral resources of that area. The topographic and geologic map work will be used in the Cowee and Pisgah geologic folios of the Federal Survey that are now being prepared.

In all the above investigations on the minerals mentioned there has always been more or less information and data collected regarding the general mineral resources of the various sections in which the investigations were carried on, thus adding to our general knowledge of the mineral resources of the State. All this information will be brought together and a volume published on the General Mineral Resources of North Carolina. This will be a volume of about 500 pages, and will include a description of every mineral that has been found in North Carolina.

The investigation of the building and ornamental stones of the State has been completed and the report published as Bulletin 2. This work has received most favorable consideration and has already been of considerable value to the State. Through the advertising of the building stones, their production in the State has increased in the past few years nearly 100 per cent. The following letter recently received will indicate how this publication has been received and what is thought of its value:

SALISBURY, N. C., December 14, 1906.

MR. JOSEPH HYDE PRATT, Chapel Hill, N. C.

DEAR MR. PRATT:—I do not know that I have ever told you how highly I value your recent publication on Building Stones in North Carolina, Bulletin No. 2. It is very complete indeed, and I have found it in matters with which I am acquainted to be thoroughly accurate. It should be worth a great many thousand dollars to this State in promoting the building-stone industry and giving reliable information to those seeking investment in that field.

Yours very truly,
(Signed) GEO. R. COLLINS.

The report on Corundum and the Peridotites of Western North Carolina, which also takes up chromite and other economic minerals associated with these rocks, has been published as Volume I. This publication has also been very favorably received, as is indicated by the many letters received and the general commendation of the press.

Bulletin 19 on the Tin Deposits of the Carolinas has also been published and has been the means of calling considerable attention to these deposits.

GEOLOGICAL INVESTIGATIONS.

During the investigations of the minerals and ores the general geology of the various regions was also studied, and the ultimate end of this work is the preparation of a geological map of the whole State, which will be made on a large enough scale so that all the geological formations can be shown in detail, which will permit of its being used advantageously by the miner, prospector and investigator.

Coastal Plain Geology.—During the fall of 1905 and summer and fall of 1906 the geology of the coastal plain region has been studied by Messrs. L. W. Stephenson, E. W. Berry, B. L. Miller, and J. E. Pogue, Jr., with special reference to strata that will contain artesian water. This work has been done in coöperation with the United States Geological Survey, and has been under the direct supervision of Mr. W. B. Clark of the Federal Survey and the State Geologist.

Mr. Stephenson and Mr. Pogue entered the field on June 13th. The larger coastal plain rivers of the State, including the Roanoke, Tar, Neuse, and Cape Fear, were traversed from or above the point where they leave the Piedmont rocks on the northwest to beyond the point where they widen out into tide-water estuaries. Tributaries of these streams, including Contentnea Creek, Northeast Cape Fear River, and Black River, were traversed along the important part of their course. The Great Pee Dee River of South Carolina was traversed across the coastal plain to Georgetown, and its subtributary, the Lumber River, in North Carolina, was traversed in part. Limited investigations were conducted in the interstream areas. The strata exposed along these streams, and in the interstream areas visited, were studied, and the main facts relating to the structure, lithologic character, etc., of the mesozoic coastal plain formations, and their relations to the overlying younger tertiary and pleistocene formations were learned. Fossils, including plants and marine invertebrates, were collected from the cretaceous deposits. The plants are being studied by Mr. E. W. Berry of Johns Hopkins University, Baltimore, and the marine invertebrates by Dr. T. W. Stanton of the United States Geological Survey, Washington, D. C. Collections of eocene and miocene invertebrates were also made, and are now being studied by Dr. B. L. Miller of Bryn Mawr College, Bryn Mawr, Pennsylvania.

In addition to these strictly geological investigations, hasty artesian water investigations were conducted in the vicinity of Greenville, Pitt County; Washington, Beaufort County, and in Hyde County; and influential citizens who were interested in the subject of artesian wells in these several communities, and well-drillers, and contractors, were interviewed.

In southeastern North Carolina, and especially in the vicinity of Wilmington, New Hanover County, hydrographic investigations begun in the fall of 1905 were continued at various times during the summer as opportunity offered.

In the vicinity of Wilmington and at a few other localities sets of well-samples, aggregating about one dozen in all, were obtained.

The results of these investigations have been to add much to the knowledge of the structure and character of the deposits of a region which, up to the present, has been but imperfectly known.

On the practical side the investigations have resulted in a better understanding of the nature of the water-bearing strata, the depths at which they occur, and roughly the quality and quantity of the water which may be expected in the different parts of the region. However, since the water-bearing strata are deeply buried and are often many miles removed from their catchment area, that is, the area in which they come to the surface, it is apparent that a complete understanding of the practical side of the subject cannot be attained to until a large number of carefully kept well-records and set of well-samples have been obtained and carefully studied and compared, and there has been made a large number of water analyses.

Mr. E. W. Berry remained in the field from June 13th to July 23d, paying special attention to the Potomac formations and to the presence or absence of plant fossils in these deposits. Sections were run from the edge of the Piedmont plateau region to the coast along the Roanoke, Neuse, and Cape Fear Rivers in North Carolina, and along the Great Pee Dee River in South Carolina. By far the most instructive section is the more or less well-known one along the Cape Fear River, and since features are brought out in this section which are more or less obscured or incomplete in other parts of the region a very brief statement of the conditions may not be amiss. Along this river the tripartite division of the later mesozoic deposits is strikingly brought out. Lying upon the uneven edges of the Piedmont crystalline or triassic rocks are the undifferentiated arkosic argillaceous, often indurated, sands of the Older Potomac, lying almost horizontally, and well exposed both above and below Fayetteville, North Carolina, and also at many other points in the State along the border of the Piedmont. Fossil plants, which form so prominent a feature in the Potomac of Maryland and Virginia, were not observed, although small basins with well-preserved plants would probably reward a more careful and extended search than it was possible to give during the past summer. Lying with a marked unconformity upon the Older Potomac is a great thickness of laminated lignitic sands and clays which are transitional in character and carry leaves having Raritan and Tuscaloosa affinities. Lithologically similar to the Magothy and Eutaw formations, and carrying marine fossils in their more or less glauconitic upper layers, it is possible that these beds represent more than one horizon during which deposition was continuous, as no discordance was observed. This is further borne out by their thickness, indicated by an outcrop at right angles to the strike of nearly fifty miles. Determinable plants were collected from two localities along the Cape Fear River and from two localities along the Neuse River, and these are being studied. It is believed that more extended search would disclose other localities carrying identifiable leaves. Above the transitional cretaceous are the widespread greensands with local calcareous layers and carrying characteristic upper cretaceous fossils. Both the Older Potomac and the transitional cretaceous develop artesian water horizons which, it is believed, will prove of great economic value with further study.

Dr. B. L. Miller was in the field from June 13th to July 3d, during which time a study was made of the sections exposed along the Roanoke River between Weldon and Plymouth, along the Neuse River from Slocum Creek to within about eight miles of Goldsboro, along the Trent River from New Bern to within a few miles of Pollocksville, and along the Cape Fear River between Wilmington and Fayetteville. In this work careful notes were taken of all good exposures and collections of eocene, miocene and pliocene fossils were made at twenty-two different localities. The collections, while not exhaustive, are representative. Small collections of tertiary fossils from fifteen other localities were made by L. W. Stephenson. All of the specimens have been carefully prepared for determination and progress is being made in this work. The results already obtained indicate striking faunal differences between the eocene and miocene of North Carolina and the States lying to the north. The discontinuous areas occupied by the tertiary within North Carolina also form a great contrast to the continuous strata of Virginia, Maryland, and New Jersey.

The absence of topographic maps and the short time spent in the field prevented much work from being done on the quaternary deposits. Fossil plants were found at one point, while some of the marine shells collected in the eastern portions of the State may prove to be of quaternary age. The great variation in thickness of the pleistocene strata is very striking, varying from 0 to 50 feet.

Messrs. Stephenson and Berry devoted their time particularly to a study of the older coastal plain formations, including the jurassic (?) and cretaceous. Dr. Miller, on the other hand, devoted his time to a study of the tertiary and quaternary formations.

By the end of the coming field season sufficient data will have been obtained for three separate volumes: one on the Underground Water Supply of Eastern North Carolina; another on the Cretaceous Formations of the Coastal Plain Region, and a third on the Tertiary Formations of the Coastal Plain Region. Of these, the one on the Underground Water Supply will take up chemical analyses of various underground waters and also certain of the river waters, and will give a record of the artesian wells of the coastal plain region, together with general information regarding the water-bearing strata and, as far as possible, their position in various sections of the State. The work will be continued during the coming field season in coöperation with the United States Geological Survey.

The banks off the coast of North Carolina have been studied for a number of years by Professor Collier Cobb, and additional data are now being collected by him regarding the movements of the dunes along the coast. The results of this investigation will be published as a bulletin on the Sand-Dunes and Reefs of North Carolina.

Another line of investigation work to be carried out in connection with these banks is in regard to the preservation of the small areas of forests that still remain upon them, and also as to the possibility of reforestation of other portions of the banks. A full description of this work is given under the head of Forestry.

Mountain Region Geology.—Besides the general study of the geological regions in which minerals and ores have been investigated, detailed geological work has been carried on in western North Carolina by Messrs. Arthur Keith, D. B. Sterrett, and H. S. Gale of the United States Geological Survey, in coöperation with the North Carolina Geological Survey. Certain definite areas covered by topographic sheets were studied, and the results will be published as geological folios by the United States Geological Survey. The following geological folios have already been published: The Asheville, covering parts of Buncombe, Madison, McDowell, Yancey, and Henderson counties; Mt. Mitchell, covering portions of Mitchell, Yancey, Madison, Buncombe, and McDowell counties; and the Cranberry, covering portions of Ashe, Watauga, Mitchell, and McDowell counties. The field work on the Morganton, Saluda, and Pisgah folios has been completed, and these will probably be ready for distribution during 1907.

BLACK SAND INVESTIGATIONS.

There is now being undertaken by the United States Geological Survey, in coöperation with the North Carolina Geological and Economic Survey, a comprehensive investigation of the useful minerals contained in placer deposits, especially those containing what is known as the black sands, and in the sands along the Atlantic seacoast. Many of these gravel deposits and sands contain, besides the precious metals gold, silver, and platinum, such minerals as magnetite, chromite, ilmenite, monazite, garnet, chrysolite, zircon, quartz, etc., which, by means of the various machines that will be used, can be separated not only from the precious metals, but from each other. Some of these minerals have a decided commercial value, and as they can be separated from each other so as to give an almost pure product of each, they can be obtained in a marketable condition. There is more or less demand for them, depending, however, upon the quantity of each that can be obtained.

It may be demonstrated that it will be possible to clean quartz sands such as occur along our sea-shores so as to obtain a sand sufficiently pure to be used in the manufacture of glass. As there are many extensive beds of these sands and gravels in North Carolina, these investigations will be of very great value to the State, and already, as a result of the preliminary work that has been done, arrangements are now being made for the installation by private individuals of a plant to be located near Morganton, Burke County, which will be erected under the supervision of the North Carolina Geological and Economic Survey, and will also be operated under their direction.

The work includes the investigation of the placer sands and gravels from all the Southern Appalachian States.

Concentrating Plant.—The installation of the concentrating plant at Chapel Hill to carry on the black sand investigations is being pushed as rapidly as possible, although there have been various serious delays on account of non-delivery of freight. This plant, which will be used in testing methods for separating the various minerals in the black sands and other placer deposits, will also be used to test the pulp obtained by crushing ores from deep mines. The larger portion of the equipment has been loaned by the various manufacturers for this work. The equipment is partly as follows:

One Wifley concentrating table, loaned by the Mines and Smelter Supply Co. of Denver, Col.;

One Wetherill magnetic separator, type E, of full size, loaned by the Wetherill Magnetic Separator Co. of New York;

One Blake-Morscher electric ore separator, loaned by the Blake Mining and Milling Co., Denver, Col.;

One 2 K. W., 125 volts, 1,400 R. P. M. compound wound No. 1 type S generator and attachments, loaned by the Westinghouse Electric and Manufacturing Company;

One 5-H. P. standard horizontal gasoline engine No. 57,371, complete with all fitting and fixtures, loaned by Fairbanks, Morse & Co. of Chicago, Ill.

One Stanwood gravity muller;

One ore crusher;

A rock crusher and ore pulverizer;

Screens, classifiers, and elevators;

A 125-cell storage battery, built and loaned by the Electric Storage Battery Co. of Philadelphia.

The concentrating plant is in charge of Mr. T. W. Johnston, but under the direct supervision of the State Geologist.

In connection with the concentrating plant there will be a well-equipped and complete assay laboratory, which will permit of the determination of the actual values of gold, silver, platinum, and other metals that the ores or sands may contain. The apparatus has been partly loaned and partly purchased of the F. W. Braun Company of Los Angeles, California, and Messrs. Eimer & Amend of New York City. It is supplied with crucible and cupelling furnaces, with complete blow-pipe apparatus; and Cary hydrocarbon burner; necessary crucibles, cupels, scorifiers, fluxes, etc.; and all necessary chemicals and apparatus for making simple mineralogical determinations. The weighing apparatus includes very fine pulp and button balances.

Tubs for panning small samples of sand have been conveniently arranged in the mineralogical laboratory. They are supplied with stop-cock connections, so that the tailings, when required, can be drawn off or saved, as desired.

EXAMINATION OF MINERAL SPECIMENS.

Specimens of minerals are constantly being received at the Survey office for examination. In many cases requests are made for chemical analyses or assays of these. As there is no regular appropriation for such analytical work, it is impossible for the Survey office to have quantitative analyses or assays made of these ores and minerals without charging the sender the cost of same. Any mineral specimens sent in will be examined and identified without any cost to the one sending the sample. Information will also be given as to the probable value of the sample, and whether, in the opinion of this office, an assay or further analytical work would be desirable. During the past two years over three hundred samples have been received, examined and reported on. Similar examinations of mineral specimens are also made by the State Geologist and his assistants while engaged in field work, and thus the actual number of specimens examined for various people throughout the State will be double the number given above.

There are at the present time about 800 individuals and companies interested in the development of mines and mineral lands in the State.

TOPOGRAPHIC AND TRAVERSE MAPPING OF THE STATE.

All of the topographic work that has been done in North Carolina has been by the Federal Survey in coöperation with the State Board of Agriculture and the North Carolina Geological and Economic Survey. While considerable progress has been made in the topographic mapping of the State, there still remains a very large area to be mapped, and as these maps are of infinite value to the State, a more liberal coöperation on the part of the State would be most beneficial to her interests. The value of these maps is not confined to any community or to any one class of people. The agriculturist and landowners will be benefited by having at hand topographic maps of their section of the country, inasmuch as they can determine the relation of all farms and houses to the slopes and water drainage of the region; bottom lands and hill lands, with their differing soils and adaptability to different crops, can be distinguished; and they are the basis of our soil maps, of which every farmer in North Carolina is in need. All timber areas will be shown on the maps; also roads, railroads, bridges, forests, rivers, streams, etc., and thus all who use country roads and who desire the construction of good roads would be benefited by having these maps. Any county that is taking up the question of road improvement and is intending to spend large sums in the construction of graded and macadam roads will find the topographic map of inestimable value, in that it not only shows the existing roads, but also shows the topography and drainage basins, and thus better grades for new roads can be readily determined and worked out. There are undoubtedly instances in North Carolina where sufficient money has been wasted in the location and construction of a poorly chosen road which would pay the cost for the preparation of a topographic map of the whole county.

All those who are interested in obtaining water supplies for towns and cities will be very materially assisted in this work by the use of these topographic maps, for the drainage basins of all the streams and rivers are accurately mapped, and an idea can be obtained of the flow of the water. This will reduce very materially the expense of preliminary surveys for the location of public water supplies and it will also lessen the chances of serious mistakes being made in the location of public water-works. In the same way these maps are of value to owners of mills and factories, to various institutions that have to rely upon their own water supplies, and to sanitary hydraulic and civil engineers.

For attracting attention to water-powers and aiding in the development of same, topographic maps have been, and will continue to be, strong factors. They show the fall per mile of the streams and rivers and give some idea of the volume of water.

Their educational value should not be overlooked, and every school in the State should have at least a full map of its own county and, preferably, a full set of the topographic maps of the whole State.

Not only will individuals be benefited by these topographic maps, but the Legislature of the State will obtain reliable information from them upon questions that may affect legislation; our courts will be able to use them for guidance in certain cases; the State Board of Health will find them of very great assistance in connection with sanitary tests; and the State Board of Agriculture will need them in their work. Thus their use and value is multiple, and covers wide interests throughout the whole State. For these reasons it is most desirable that the topographic mapping of the State be pushed forward just as rapidly as possible. The State, by coöperating with the Federal Survey, can secure more rapid progress in this work and by appropriating from its own treasury a certain amount, the Federal Survey will appropriate an equal amount to carry on particular topographic work in the State, this allotment to be in excess of the regular allotment that would naturally be used in the regular topographic mapping of North Carolina. I would, therefore, most earnestly recommend that the Legislature appropriate from the treasury of the State a sum of not less than $10,000 per year until this most important work is completed, provided that an equal amount is expended each year by the Federal Survey for this work in the State.

Traverse Maps.—In making the topographic maps the first work to do would be the preparation of a traverse map showing location of streams, roads, prominent peaks and showing levels at approximately every six miles, but would not, of course, show any contour lines. Such maps could be finished much faster and cover a greater territory than the topographic maps, and would be of very great value in the soil, geological and mineralogical work. Such maps would also be prepared under the coöperative system with the Federal Survey. During the past year the North Carolina Survey had an accurate traverse map made of about 75 square miles of area in Swain County in connection with the investigation of the copper ores.

GOOD ROADS.

There continues to be very great interest throughout the State in the construction of good roads; and while as yet only a small proportion of the counties has taken up the construction of macadam roads, still each year sees one or two new counties added to those that are constructing graded macadam roads. The value of good roads to a community, county and State is being emphasized more and more each year, and their practical and commercial value are now realized by most of the people. One striking fact is to be noted in connection with the construction of macadam roads throughout the State, and that is that no county which has once begun the construction of macadam roads has stopped this work. In each case the county has appropriated more and more until the whole county is traversed by good roads.

In order to facilitate the construction of good roads throughout the State, the State could not make better use of a portion of its income than by expending a certain amount of this in State aid to counties in the construction of macadam or other permanent roads. The benefit to be derived from the construction of good roads in the various counties composing the State is not only of great value to the individual county, but also to the State as a whole. They will mean a large increase in the revenue of the State due to the increase in the value of real estate; they will mean a large increase in population due to immigration, which will not take place with poor roads, and we can undoubtedly trace the lack of immigration in North Carolina largely to the existence of poor roads throughout the State. They will mean better schools, and good roads and good schools are the best advertisement of a State's prosperity.

It is a significant fact, and one worthy of consideration, that no State which has once inaugurated State aid in the construction, supervision and investigation of its public highways has ever given up this work, but has made it permanent, and in most cases has widened its scope and increased its appropriations. The following States are now aiding in the construction and maintenance of their public highways: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Maryland, Virginia, Illinois, Michigan, Iowa, Colorado, Utah, California, and Washington. Thus far, Maryland and Virginia are the only two Southern States that are aiding their counties and towns in the construction of public roads.

When it is considered that there are approximately 49,763 miles of public roads of all kinds throughout the State, of which only about 1,350 miles are improved roads, surfaced either with stone, gravel or sand-clay mixtures, the need of State aid in the construction of good roads becomes very apparent. There is given in the following table the mileage of public roads in the various counties, together with the expenditures in 1904, both in money and labor, in the maintenance and construction of public roads. This table has been taken from a report of the Office of Public Roads, Circular No. 45, of the United States Department of Agriculture. The State Geologist assisted to some extent in revising and collecting certain of the statistics used in this table:

MILEAGE AND EXPENDITURES IN 1904.

County.	Miles of Public Roads.				Expenditures in Money and Labor.						Total Amount of Property and Labor Tax.
					Property Tax.		Labor Tax.				
	Total of all Public Roads.	Surfaced with Sand-clay Mixtures.[1]	Surfaced with Gravel.[1]	Surfaced with Stone.[1]	Road Levy—Rate Per $100.	Amount of Tax.[2]	Number of Men Subject to Tax.[3]	Number of Days' Labor Required Per Annum of Each Individual.	Value of One Day's Labor.	Value of Labor Tax.	
Alamance	540			10	$0.166	$12,996.47	3,085	3	$0.75	$6,941.25	$19,937.72
Alexander	500						1,500	6	1.00	9,000.00	9,000.00
Alleghany	260						1,100	8	.75	6,600.00	6,600.00
Anson	500		15	10		[4]6,516.30	500	6	.75	2,250.00	8,766.30
Ashe	600				.10	2,900.00	1,000	8	.75	6,000.00	8,900.00
Beaufort	350		4				3,500	6	.75	15,750.00	15,750.00
Bertie	700						2,500	6	1.00	15,000.00	15,000.00
Bladen	180						2,000	6	1.00	12,000.00	12,000.00
Brunswick	300						800	4	1.00	3,200.00	3,200.00
Buncombe	700			35	.15	20,000.00	1,400	4	1.00	5,600.00	25,600.00
Burke	383		2	2	.05	5,000.00	1,643	6	1.00	9,858.00	14,858.00
Cabarrus	332		20	12	.25	16,064.06	1,500	4	.75	4,500.00	20,564.06
Caldwell	1,200						2,500	6	.75	11,250.00	11,250.00
Camden	200						800	6	.75	3,600.00	3,600.00
Carteret	[5]150						500	3	1.00	1,500.00	1,500.00
Caswell	500						1,250	6	.75	5,625.00	5,625.00
Catawba	400						3,000	6	1.00	18,000.00	18,000.00
Chatham	400				.10	6,000.00	3,000	4	.75	9,000.00	15,000.00
Cherokee	400				.10	3,500.00	2,000	6	1.00	12,000.00	15,500.00
Chowan	150				.25	3,600.00	800	6	1.00	4,800.00	8,400.00
Clay	150				.20	1,600.00	800	6	.75	3,600.00	5,200.00
Cleveland	650						4,000	6	1.00	24,000.00	24,000.00
Columbus	400				.10	6,439.00	3,395	6	1.00	20,370.00	26,809.00
Craven	250	2		1			150	6	.75	675.00	675.00
Cumberland	200	45				5,000.00					5,000.00
Currituck	140		50				1,000	6	.75	4,500.00	4,500.00
Dare	1,000						500	5	1.00	2,500.00	2,500.00
Davidson	100				.15	3,635.62					3,635.62
Davie	350						1,700	6	.75	7,650.00	7,650.00
Duplin	800						2,000	6	.75	9.000.00	9,000.00
Durham	550			45	.15	22,378.16	1,000	4	.75	3,000.00	25,378.16
Edgecombe	650	2			.15	11,665.00					11,665.00
Forsyth	1,000			8	.25	35,000.00					35,000.00
Franklin	550		40		.25	3,000.00	450	6	.75	2,025.00	5,025.00
Gaston	300			19	.25	21,000.00	4,200	2	.75	6,300.00	27,300.00
Gates	250						1,400	6	1.00	8,400.00	8,400.00
Graham	200				.40	3,600.00	600	6	.75	2,700.00	6,300.00
Granville	650		15	2	.16	6,701.46	3,000	4	.75	9,000.00	15,701.46
Greene	400		50								
Guilford	700	100		30	.123	[6]45,000.00	2,000	4	.80	6,400.00	51,400.00
Halifax	700				.12	8,000.00			.75		8,000.00
Harnett	800						3,500	6	.75	15,750.00	15,750.00
Haywood	150		10	5	.30	14,000.00	2,000	6	.60	7,200.00	21,200.00
Henderson	500				.10	400.00	1,750	6	.75	7,875.00	8,275.00
Hertford	[5]500						792	6	1.00	4,752.00	4,752.00
Hyde	225						925	6	1.00	5,550.00	5,550.00
Iredell	300		2	6	.15	12,000.00					12,000.00
Jackson	340				.15	5,751.75	1,788	4	.85	6,079.20	11,830.95
Johnston	800	100			.25	7,000.00	900	6	.75	4,050.00	11,050.00

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[1] Where figures are not given in these columns, no mileage has been reported.

[2] Where figures are not given in this column, no cash road levy was made.

[3] Where figures are not given in this column, no labor tax was levied, and convict labor was used for road work.

[4] Of this amount, $6,058.30 was realized from the sale of bonds.

[5] Includes 4 miles surfaced with shells.

[6] Of this amount, $35,000 was realized from the sale of bonds.

MILEAGE AND EXPENDITURES IN 1904—*Continued.*

County.	Miles of Public Roads.				Expenditures in Money and Labor.						Total Amount of Property and Labor Tax.
					Property Tax.		Labor Tax.				
	Total of all Public Roads.	Surfaced with Sand-clay Mixture.[1]	Surfaced with Gravel.[1]	Surfaced with Stone.[1]	Road Levy—Rate Per $100.	Amount of Tax.[2]	Number of Men Subject to Tax.[3]	Number of Days' Labor Required Per Annum of Each Individual.	Value of One Day's Labor.	Value of Labor Tax.	
Jones	400	----	----	----	$----	$---------	750	6	$ .75	$ 3,375.00	$ 3,375.00
Lenoir	500	9	----	----	.133	[5]9,320.00	----	----	.60	----	9,320.00
Lincoln	450	----	----	----	.15	4,414.30	708	6	.75	3,186.00	7,600.30
McDowell	150	----	----	----	----	1,200.00	1,100	6	1.00	6,600.00	7,800.00
Macon	750	----	----	----	.30	6,000.00	1,500	6	.75	6,750.00	12,750.00
Madison	300	----	----	----	.05	2,000.00	2,000	8	.75	12,000.00	14,000.00
Martin	400	----	----	----	----	----	1,800	6	.75	8,100.00	8,100.00
Mecklenburg	850	----	3	144	.35	85,422.73	3,800	4	1.00	15,200.00	100,622.73
Mitchell	700	----	2	----	.14	1,800.00	2,100	6	1.50	18,900.00	20,700.00
Montgomery	500	----	----	----	----	----	2,000	6	.75	9,000.00	9,000.00
Moore	700	----	17	----	.24	1,800.00	2,000	6	.75	9,000.00	10,800.00
Nash	700	----	----	----	.25	2,038.92	4,500	6	.75	20,250.00	22,288.92
New Hanover	104	----	81	23	.40	[6]22,017.27	600	5	.40	1,200.00	6,125.30
Northampton	600	----	----	----	.20	13,659.00	1,950	3	1.00	5,850.00	19,509.00
Onslow	588	----	----	----	----	----	2,119	6	1.00	12,714.00	12,714.00
Orange	200	----	----	----	.15	6,500.00	1,200	4	.75	3,600.00	10,100.00
Pamlico	180	----	----	----	----	----	1,400	6	.50	4,200.00	4,200.00
Pasquotank	250	----	----	----	.10	2,391.48	1,500	4	1.00	6,000.00	8,391.48
Pender	1,300	----	----	----	----	----	2,000	6	.75	9,000.00	9,000.00
Perquimans	325	----	----	----	----	----	1,300	6	1.00	7,800.00	7,800.00
Person	600	100	----	----	.15	5,000.00	400	4	.75	1,200.00	6,200.00
Pitt	2,000	----	----	----	----	4,000.00	2,000	2	.75	3,000.00	7,000.00
Polk	200	----	----	----	.15	1,600.00	400	4	.50	800.00	2,400.00
Randolph	500	----	----	----	.083	5,331.52	6,200	6	.75	27,900.00	83,231.52
Richmond	200	----	3	----	----	----	1,750	6	.75	7,875.00	7,875.00
Robeson	1,500	35	----	----	.75	30,000.00	----	----	.75	----	30,000.00
Rockingham	700	----	----	2	.08	12,000.00	2,500	3	1.00	7,500.00	19,500.00
Rowan	300	----	2	26	.25	26,507.00	5,000	4	1.00	20,000.00	46,507.00
Rutherford	900	----	----	----	----	[7]500.00	1,200	6	1.00	7,200.00	7,700.00
Sampson	500	----	----	----	----	----	3,600	6	1.00	21,600.00	21,600.00
Scotland	240	15	----	----	.15	4,500.00	750	4	.80	2,400.00	6,900.00
Stanly	800	----	----	----	.083	3,300.00	2,000	4	.75	6,000.00	9,300.00
Stokes	600	----	----	----	----	----	2,500	6	.75	11,250.00	11,250.00
Surry	500	----	----	----	----	200.00	3,000	6	.75	13,500.00	13,700.00
Swain	300	----	----	----	----	----	1,200	10	1.00	12,000.00	12,000.00
Transylvania	200	----	----	----	----	----	1,200	10	.75	9,000.00	9,000.00
Tyrrell	136	----	----	----	----	----	400	6	1.00	2,400.00	2,460.00
Union	1,000	----	44	----	.20	11,260.00	3,000	6	1.00	18,000.00	29,260.00
Vance	200	30	----	----	----	----	400	2	.75	600.00	600.00
Wake	1,560	----	27	18	.15	[8]41,539.43	4,150	6	.75	18,675.00	60,214.43
Warren	400	----	25	----	.25	10,500.00	1,750	4	.75	5,250.00	15,750.00
Washington	200	----	----	----	----	----	1,000	5	1.00	5,000.00	5,000.00
Watauga	200	----	----	----	----	----	2,000	6	.65	7,800.00	7,800.00
Wayne	1,000	----	----	----	----	5,000.00	2,500	6	.75	11,250.00	16,250.00
Wilkes	1,500	----	----	----	----	----	3,318	6	.75	14,931.00	14,931.00
Wilson	530	----	10	1	.15	14,000.00	----	----	.50	----	14,000.00
Yadkin	500	----	----	----	----	----	2,000	6	.75	9,000.00	9,000.00
Yancey	300	----	----	----	.10	1,831.31	1,000	6	.60	3,600.00	5,431.31
Total	49,763	438	422	399	----	624,380.78	161,773	----	----	734,306.45	1,358,687.23

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[1] Where figures are not given in these columns, no mileage has been reported.
[2] Where figures are not given in this column, no cash road levy was made.
[3] Where figures are not given in this column, no labor tax was levied, and convict labor was used for road work.
[4] Includes 1 mile surfaced with shells.
[5] Includes amount received from labor tax of 40 cents on 3,300 persons.
[6] Of this amount, $17,091.97 was realized from the sale of bonds.
[7] This amount was used for bridges.
[8] Of this amount, $18,000 was realized from the sale of bonds.

Since the figures were obtained for this table there have been approximately 100 miles more of good roads constructed throughout the State.

It is the opinion of the State Geologist that in order to obtain the most satisfactory expenditure of labor and money in the repair and construction of the roads throughout North Carolina there should be some State supervision of its public roads. This could be done through a Highway Commission, who would have in its employ road engineers. There is undoubtedly sufficient money and labor expended each year by the various counties to thoroughly repair the present public roads, if this was judiciously expended under the supervision of one who has been trained in the construction of public roads. If all this money and labor could have been expended according to plans drawn up by the engineers of a Highway Commission, the roads would be made in a uniform manner and the money would have been expended so as to give the most practical results. When the State is so vitally interested in its roads and they mean so much to the prosperity of the State, it is only right that the State should interest itself in the construction of its roads. We have a State Board of Education who have general supervision of the schools throughout the State, and why should we not have a Highway Commission, who would have general supervision of the construction and repair of roads throughout the State?

The construction of a macadam or other improved surfaced road will mean—

1. That the market value of the real estate situated on or near the macadam road will be enhanced in value, and in many instances properties which could not be sold, even at a low figure, have found a market when they were connected with the neighboring town or city by means of a macadam road.

2. That rural free delivery will be extended as good roads are constructed, and is practically dependent upon good roads, for, with the construction of good roads there will be an increase in population and of the earning capacity of the adjacent farms, which will mean a greater amount of mail matter to be delivered. This is emphasized in the report of Postmaster-General Cortelyou, who said: "The requirement precedent to the establishment of rural delivery is to be a possible patronage of 100 families on a standard route of 24

miles; that the road be kept in good condition, unobstructed by gates, and with all streams fordable at all seasons of the year."

3. That farmers will be able to take advantage of market fluctuations in buying and selling.

4. That the farmer, fruit-grower, and others will be able to economize time and force in transportation between country and market.

5. That the wear and tear on horses, harness and vehicles will be reduced.

6. That better educational facilities will be possible in the rural districts, for it will not be necessary to have as many school districts and so many divisions of the school funds. The districts can be consolidated, thus permitting larger and better schools, insuring better teaching and more enthusiasm on the part of both pupil and teacher.

7. That tourists, capitalists, investors, and others visiting any section of the State will be much more favorably impressed with the financial possibilities of manufacturing enterprises or the commercial value of any farm or timber land by driving to them over good roads. If these same places have to be visited over poor roads, they will lose more than half their value in the sight of the prospective investor, as his thoughts have been so entirely taken up with the bad road over which he has been compelled to travel.

The Geological Survey is attempting, as far as possible, to give assistance in regard to the location of roads and the methods of construction of same in the various counties. The members of the Survey have been ready to meet with committees and deliver addresses in the counties regarding the value of public roads, best methods of constructing same and on the question of issuing bonds by counties. The Survey has also been ready to assist in the construction of the first mile of macadam road in any county by furnishing an engineer to give instruction and superintendence in the work. The State Geologist would most earnestly recommend that the present Legislature give serious consideration to the question of State aid for the constructing of public roads throughout the counties. This work is one of the most important that can be done by the State, and at least $100,000 annually could be spent most advantageously by the State in coöperation with the various counties. The amount that the State would appropriate for this purpose would be allotted proportionately to each county. Any county desiring to avail itself of this amount would be required to appropriate from its own treasury a like amount also, to be used in the construction of public roads within the county. The counties would be obliged to signify their acceptance of the State appropriation within a given time after the allotments were made and at the end of this time the amount appropriated to the counties not accepting the allotment would be reapportioned to the other counties. Thus, it would undoubtedly be the case that for a number of years there would be a number of counties that would not appropriate anything, and, therefore, the other counties who are fully alive to the value of macadam roads would be able to obtain a larger allotment from the State; but in every instance the county would be obliged to appropriate an amount from its treasury equal to whatever amount it would receive from the State appropriation.

In order to stimulate public opinion regarding good roads and to discuss various questions relating to this question, a series of Good Roads Circulars have been published from time to time by the North Carolina Geological and Economic Survey in coöperation with the North Carolina Good Roads Association. Forty-one of these circulars have now been published, of which the following is a copy of Circular No. 40:

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY.

GOOD ROADS CIRCULAR No. 40.

BY JOSEPH HYDE PRATT,

State Geologist and Secretary of the North Carolina Good Roads Association.

PUBLIC ROADS AND IMMIGRATION.

The State of North Carolina is at the present time extremely interested in the subject of immigration and, through its several departments, is making considerable effort to bring certain classes of European immigrants into the State. Many inducements have been circulated abroad for those seeking desirable and permanent homes, such as its excellent climate, which should be attractive to many from the southern part of Europe; its thousands of acres of fertile land that can be obtained very cheaply and on very reasonable terms; the large demand for labor which assures their easily obtaining employment in the neighborhood of their homes the year round and at good wages, this demand for labor including farmers, household servants, miners, mechanics and the most skilled workmen.

It is not the desire of the State to simply obtain an influx of labor, but to obtain an influx of home-seekers to become citizens of the State and at the same time furnish the kind of labor that is needed. We desire the better class of home-seekers, and these will want and demand school facilities for their children and good roads to connect them with town and railroad. The class of European immigrants that are desired in North Carolina have been accustomed in their own country to excellent roads, and it is natural and to be expected that a section of country that is traversed by good roads connecting the various farming districts with markets and providing easy means of intercourse between different neighborhoods will be more attractive than those districts in which the roads are poor and at some times of the year almost impassable.

We not only want European immigrants: we want to attract Americans from other sections of the United States to the South to invest in our farm lands, our water-powers and to build up manufacturing industries. Good roads are of vital importance to these classes of men. A man examining a farm district with the intention of investing in a farm will be more favorably impressed with the district if he can be driven to his destination over a good road so that his entire attention can be given to the farm lands that he is passing. On the other hand, if the road is poor, as so many of our North Carolina roads are at the present time, so that his attention is constantly being called to the road by reason of holes, ruts, stones and the general inconvenience of the road over which he is obliged to go, he has little thought for the beauties of the country or the value of the farming land, and his chief desire is to get back to the city and railroad. There is no doubt but hundreds and even thousands of good farms in North Carolina remain wholly or partially uncultivated and unproductive on account of the very poor condition of the roads connecting them with town and market.

If the railroads consider it necessary to improve their road-beds and their rolling-stock in order to build up a certain section of the country and spend large sums advertising the railroad facilities of the section in their attempts to induce labor and capital to locate there, how much more important that the counties and towns should improve their public roads, making them as far as possible macadam roads, and thus offer the strongest inducements for capital and labor to invest in their districts.

There is a certain class of immigrants that would probably pay little or no attention to the roads in the districts where they might settle; but is this the class of immigrants that North Carolina desires to have located within her borders? We can say emphatically, no. But we do desire those immigrants who will want and demand good roads, who will take a pride in keeping these roads, who will become public-spirited men, and instead of making the roads dumping grounds for waste materials of all kinds, clogging the ditches with trash, stones, brush, etc., will take pride in keeping the roads where they pass their farms clean, the grass and weeds cut, and remove waste material instead of dumping it into the roads.

The counties that are attracting the most capital and labor are those in which the roads are in the best condition. These counties will continue to derive the most benefit from any movements that are made for bringing immigrants into North Carolina. Good county roads indicate a prosperous county, and this is well illustrated in North Carolina where the richer, more progressive and more liberal counties are those which have spent a great deal of money in building good and permanent public roads.

It is a substantiated fact that no State in the Union is so attractive to every class seeking new homes and new investments as North Carolina. Most of these will select their locations on good roads. Some will be deterred from investing on account of the poor roads in the sections that they had expected to settle.

Many do not want to settle in our cities, towns or even villages, but want to be out on farms five or ten miles from the city or town, and want to be connected with the city by good roads. If good roads are so important to those coming into North Carolina, whether they be capitalists, health, pleasure, or home-seekers, or laborers, how much more important should good roads be to those already settled in North Carolina.

CHAPEL HILL, N. C., June 25, 1906.

The construction of improved roads in eastern North Carolina is complicated by the lack of material for macadam, and in many cases, of gravel, for making gravel roads. One solution of this problem is the construction of sand-clay or burnt-clay roads, which is possible in many sections of eastern North Carolina. The construction of sand-clay roads in North Carolina has passed the experimental stage, and it has been proved that they are well adapted for light traffic, and even under heavy traffic they have proved satisfactory to a great extent. There are certain sand-clay roads in the South Atlantic States over which heavy loads of cotton and other farm products are hauled throughout the year with but little real damage to the road. There are many sections of North Carolina where the construction of a sand-clay is, perhaps, the cheapest solution of the problem of road improvement for that particular section. Considerable care must be exercised in the construction of a sand-clay road, and in order to encourage the construction of this class of roads, the Office of Public Roads of the United States Department of Agriculture has issued Bulletin No. 27 on the Construction of Sand-clay Roads, by W. L. Spoon, who is one of the road experts of the Office of Public Roads, and also acts as road engineer of the North Carolina Geological and Economic Survey. Mr. Spoon has, during the past two years, superintended the construction of sand-clay roads in the vicinity of Kenansville, Duplin County.

Another form of road that may be used to advantage in certain localities is the burnt-clay road. Methods for the construction of this kind of road are also given in Bulletin No. 27, referred to above.

HYDROGRAPHY.

Artesian Water Supply.—As the study of the artesian water supply in eastern North Carolina is very closely related to the geological investigations of the coastal plain region, the work done along this line has practically been given under Coastal Plain Geology. While we are not yet in a position to give accurate information regarding the water-bearing strata in North Carolina, yet the information that has been obtained is of very great value in working out the problem of artesian water supply for this section of the State. With another year's field work, data will undoubtedly be obtained that will be of very material assistance in determining locations of drilling artesian wells. It is of very great assistance to have accurate records kept of all the wells that are being bored in North Carolina, and the State Geologist would appreciate it if all those who are boring wells, or contemplating doing so, would notify him, so that arrangements can be made for saving records from these wells which can be studied by the geologists in charge of this work. The greater number of well-records that can be obtained, the quicker more definite information can be given regarding the water-bearing strata, and it would undoubtedly be of considerable advantage to many of the counties in eastern North Carolina as well as to the State as a whole, if the counties would coöperate with the Geological Survey in boring a certain number of wells at points to be determined by the Survey and under the general direction of the Survey.

Stream Measurement.—Stream-gauging stations are maintained by the Hydrographic Branch of the United States Geological Survey, in coöperation with the North Carolina Geological and Economic Survey. At the present time there are thirteen of these stations at the following places: Bryson City, Davidson River, Horseshoe, Judson, Madison, Morganton, Murphy, North Wilkesboro, Pink Bed, Ranger, Salisbury, and Sittom. It is expected that the number of stations will be considerably increased during 1907, so as to include some in the central part of the State. At the present time the North Carolina Survey is paying the expenses of seven of these river observers. There is now in preparation an Appendix to Bulletin No. 8 on the Water-powers of North Carolina, which will give, up to January 1, 1907, all data that has been collected relating to gauge readings at the various stations since 1898, and also all discharge measurements that have been made and recorded. This publication should be a valuable addition of Bulletin 8 and be of considerable service to those interested in the development of water-powers throughout North Carolina.

In order to preserve our water-powers, it is absolutely essential that the forests on the mountain slopes in which these streams have their source should be protected, and this has been attempted through the efforts made relating to the creating of the Appalachian Forest Reserve, a discussion of which is taken up under the head Forestry.

Mineral Waters.—Some years ago an investigation was started relating to the mineral waters of North Carolina. Chemical analyses were made of the waters from many of the springs, and it is hoped that the additional data required to complete the manuscript can be collected and brought together during the coming year, so that this volume can be sent to the printer. There is a considerable demand for such a report, and it is believed that there is an opportunity of building up an industry of considerable importance to the State in the sale of mineral waters. There is at the present time a small amount of spring water that is being put on the market. Most of this that is bottled and sold is used for medicinal purposes, and there is very litle that is marketed which could be called a purely table water. Spring water is being used more and more for table use and North Carolina has springs of large flow whose water is pure and, if once introduced on the market, would undoubtedly find wide favor as table water. There are now fourteen springs from which, from time to time, the water has been bottled and shipped. They are as follows:

Alkalithia Spring, Alkalithia Springs, Alexander County.
Ashley Bromine and Arsenic Springs, Ashe County.
Barium Rock Springs, Barium Springs, Iredell County.
Buckhorn Lithia Springs, Bullock, Granville County.
Lemmon Spring, Lemmon Spring Station, Moore County.
Jackson Spring, Jackson, Moore County.
Haywood White Sulphur Spring, Waynesville, Haywood County.
Mida Spring, near Charlotte, Mecklenburg County.
Panacea Spring, near Littleton, Halifax County.
Parks Mineral Spring, Caswell County.
Red Spring, Red Springs, Robeson County.
Seven Springs, near Goldsboro, Wayne County.
Thompson Bromine-Arsenic Springs, Crumpler, Ashe County.
Vade Mecum Springs, Stokes County.

Many of the springs have hotels run in conjunction with them, which will accommodate many thousand people. In many instances it is the fact of the presence of the springs that makes the hotels possible and profitable.

FORESTRY.

Perhaps the most important work in forestry that has been undertaken during the past two years has been in relation to the establishment of the Appalachian Forest Reserve in the Southern Appalachians. Numerous newspaper and magazine articles have been written and published by different members of the Geological Survey staff setting forth the great value and need of such a forest reserve to North Carolina. The following article by the State Geologist takes up these questions in detail:

THE SOUTHERN APPALACHIAN FOREST RESERVE.*

BY JOSEPH HYDE PRATT.

The forest wealth of North Carolina, Tennessee, Georgia, and South Carolina makes the establishment of a Southern Appalachian Forest Reserve of very great interest to these States; but as these forests affect industries throughout all of the Southern States, and thus affect the industries of the entire country, the establishment of this Forest Reserve is a matter not only of State but also of National interest and concern. One hundred years ago there was little or no attention given in this country to the method or means by which its forests were cut away; that is, whether they were cut for lumber or ruthlessly destroyed in the clearing of land for agricultural purposes. There was no thought paid to the prevention of forest fires because they were harmful to the forests themselves; and no thought whatever was given to the influence that forests exert on the flow of streams and rivers. At that time there seemed to be a superabundance of lumber for all purposes, the wasteful destruction of which could not then be felt. Forest fires were not considered particularly harmful as long as they did not come too near the habitations of men. The streams and rivers always contained plenty of water and for a quarter of a century not enough land was cleared of forests to demonstrate the effect their removal had upon the water supply.

At the beginning of the 20th century, however, there has been a decided change in the views and ideas regarding the value to a country of its forest resources. Thus, our leading statesmen and citizens now realize and appreciate not only the commercial value of the perpetuation of the forests, but also the vast influence that these forests exert in the preservation of the water supply of the country. This is especially noticeable in mountainous and hilly sections. When these are covered with abundant forests, the decay of the fallen leaves form a loam which prevents the water from running off the surface too rapidly and washing away the soil or cutting deep gorges or ravines in the slopes of the hills. These forest-covered mountains are extremely valuable because of the effect they have upon water supply and water-powers.

By the removal of the forests there is no longer a protection for the soil on the slopes of the mountains and hills, except that produced artificially in the form of ditches, etc. There is no longer a layer or bed of leaves to act as an absorbent for the water and a preventive to its evaporation, and it runs off for the most part as fast as it falls, causing high freshets and floods and periods of extreme low water; causing the streams and rivers to be higher at times of floods, but very much lower the greater part of the time than they were before the removal of these forests. This is well illustrated at the present time in many parts of eastern United States where many of the rivers are not navigable to the extent that they formerly were.

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*Printed in the Journal of the Elisha Mitchell Scientific Society and distributed at a meeting held in Charlotte March 3, 1906.

To keep many of these open for navigation is now a constant expense to the National Government. While a great deal of damage and expense has already been caused in this way, there will be a still greater harm done if the remaining forests are not protected. It is not only the navigation of the streams and rivers that is hurt by the removal of the forests, but also the water supply for our cities and towns. Many of our largest cities are already beginning to find some difficulty in storing a sufficient supply of water for their use.

This preservation of the forests means also the maintenance of the water-powers, which, if reduced or destroyed, will seriously injure many of our manufacturing interests.

These defects in the water supply are not due to lack of rain, but to the removal of the natural agencies that nature has provided for the storing of this water. Again, these defects are not due to any considerable extent to the clearing of land for farming purposes, for the farmer must of necessity protect the soil from being washed away, and the only loss to the water supply that he would cause would be the greater evaporation to which it would be exposed. They are, however, due to the wasteful and destructive removal of the forests by the lumber companies, who leave large tracts of land stript in some cases of every vestige of a tree.

The present method of cutting timber and the subsequent forest fires is causing a scarcity of lumber, especially of the hardwoods, and there are now but few sections in this country where virgin forests of this character are to be found. This total destruction of a forest in lumbering is not necessary, but is a wasteful destruction of property, and a forest-covered area which should be a constant source of revenue, becomes in the end waste land, and in many cases an impoverished, barren tract.

This scarcity of hardwoods can be remedied by the application of practical forestry which would be adopted in any forest reserve established in the Southern Appalachian mountains and is now being practiced in the forest reserves of the western part of this country. There is little or no doubt but that the forests of the Southern Appalachian mountains can, by systematic and conservative measures, be made to yield profitable returns to the State and country. The forests of North Carolina and Tennessee are, and have been for many years, one of the chief resources of revenue to the people of these States, and their preservation and perpetuation means a constant source of revenue to these States.

Thus the two main and vital reasons for forest reserves are, first, the protection of the water supply of our streams and rivers; and second, the protection of our supplies of lumber, especially the hardwoods.

The region that is to comprise the proposed Appalachian Forest Reserve lies for the most part in western North Carolina and eastern Tennessee, with smaller areas in southwestern Virginia, northeastern Georgia, and northwestern South Carolina. The slopes of the mountains in this region are the sources of many large rivers, as the Tennessee, the Savannah, the Broad, and the Catawba. The water-power and navigation of these rivers are seriously affected by the removal of the forests in the mountainous districts, as is also the water supply for the towns and cities in the vicinity of the mountains and of these rivers. This southern section of the United States has not been subjected to glacial action as the Northern States have, and there are, therefore, no glacial drifts to act as storage reservoirs for water. Thus, in the removal of the forests we are practically removing all the natural resources for storing water.

In speaking of forest reserves and particularly of the proposed Southern Appalachian Reserve, President Roosevelt in his address at Raleigh, N. C., October 20, 1905, pointed out how vital the preservation of the forests is to the welfare of every country, and that the upper altitudes of the forested mountains are most valuable to the Nation as a whole, not only on account of their commercial value as supplies of lumber, but especially because of their effects upon the water supply. He further said: "Neither State nor Nation can afford to turn these mountains over to the unrestrained greed of those who would exploit them at the expense of the future. We cannot afford to wait longer before assuming control, in the interest of the public, of these forests; for if we do wait, the vested interests of private parties in them may become so strongly intrenched that it may be a most expensive task to oust them. If the Eastern States are wise, then from the Bay of Fundy to the Gulf we will see, within the next few years, a policy set on foot similar to that so fortunately carried out in the high Sierras of the West by the National Government. All the higher Appalachians should be reserved, either by the States or by the Nation. I much prefer that they should be put under National control, but it is a mere truism to say that they will not be reserved by the States or by the Nation unless you people of the South show a strong interest therein."

North Carolina, which would give the largest area to the Appalachian Forest Reserve, is unequalled in its variety of hardwoods and conifers by that of any other State or Territory.* Throughout the whole area of the State the great variety of soils and climate has brought together trees from all parts of Eastern America, so that twenty-four kinds of oaks are to be found in the State, which is three more than occur in any State to the north of this one, and two more than are to be found in any State to the south; of the nine kinds of hickories known to occur in the United States, eight have been found in North Carolina; here are all six maples of the Eastern United States; all the lindens; all six of the American magnolias; three of the birches; eight pines out of eleven; both species of hemlock and balsam-fir; three elms out of five; six arborescent species of plum and cherry; and three of pyrus (apple).

The bleak and exposed mountain summits bear forests of trees which there find their southern limit, but extend northward through northern New York and New England to Canada. Such trees are the black spruce (the balsam), striped and spiked maples, mountain sumac, which is really an apple, balsam-fir, and aspen—all, unless sheltered by other trees or by the slopes of the mountain above them, rugged and dwarfed from the cold and constant wind to which they are exposed.

The commercial forest trees are on the slopes of the mountains and in the ravines and valleys. Some of these trees have wide distribution to the north of North Carolina or to the south of it, or in both directions, and some of them are restricted in their distribution to North Carolina or to the region around the southern Appalachian Mountains.

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*Publication of the North Carolina Geological Survey on Forests of North Carolina. Bulletin No. 6.

The mossy cup, yellow and shingle oaks, white linden and big shag-bark hickory, prominent trees of the Central States, extend as far to the southeast as central North Carolina; while trees of the north, like hemlock, sugar or hard maple, northern red-oak, cherry, birch, and white pine, and of the northeast, like the pignut hickory, chestnut, northern pitch-pine, and balsam, enter more or less largely into the composition of the forests of the western part of the State.

Many trees of wide distribution, and among them some of the most valuable, extend from this State in all directions, the white, post, black, scarlet, and Spanish oaks, the red and white maples, the white, brown heart, and shag-bark hickories, short-leaf pine, yellow poplar, red cedar, black cherry, and black walnut. The cypress, water and willow oaks, downy poplar, swamp white-oak (Q. Michauxii, Nutt.), southern elm, and planer trees are trees having a great range to the south and southwest. A few trees are found only in this State, or extend but a short distance beyond its boundaries, the yellow-wood, the large-leafed umbrella tree, the Carolina hemlock, and the clammy locust, the last being entirely confined to this State.

Altogether, 153 kinds of woody plants, which form a simple upright stem and attain arborescent proportions, grow naturally within the State; and of these over seventy are trees of the first size, and fifty-seven are trees of great economic value. Fourteen of these are known to attain a height of over 100 feet, three of them a height of over 140 feet; sixteen of them reach diameters of five feet or over, and five reach diameters of seven feet or over.

The areas of the other States included in the proposed Forest Reserve also contain a large variety of trees, and thus this whole region contains the greatest variety of hardwoods to be found anywhere on the American Continent, for it is here that there is an intermingling of the sylva of the North and South. Here trees that are common to New England are found in close proximity to those that are common to the more Southern States. Here is the largest area of virgin forests to be found in the Southern Appalachian region. Here are trees from five to ten feet in diameter which often tower to a height of 140 feet. The destruction of such a forest would be an almost irreparable loss, for once destroyed it would take generations for its restoration, with a great probability of failure; and then again the chances are that it would not be attempted.

These areas of timber are being rapidly acquired by those whose one object is to make the most profit possible out of them at the present time, with no thought for the future. Many of the older countries, as Germany and England, have suffered to such an extent by the destruction of their forests that they, especially Germany, have begun already to take measures to preserve their forests and to make them such that they will be a constant source of lumber, and Germany has shown that by her system these forest reserves become self-supporting. England has become so depleted of her timber that she is obliged to import the greater part of her lumber.

The only remedy for the protection and preservation of our forests is for the National Government to obtain possession of them and to care for them by the application of scientific methods.

Such a forest reserve under the management of trained forest experts will demonstrate how these forests can be perpetuated and at the same time be made to pay. Such an example will have an influence on the several States and individuals by encouraging them to practice forestry and to use those lands for growing timber that are more suited for this purpose than for farming industries. It will be an object-lesson and a laboratory for those studying or interested in forestry.

The acquirement of this land by the National Government for a forest reserve will not be setting a precedent, for "nearly 50,000,000 of acres of forest-covered lands have been set aside (in the Western States) as National Forest Reserves and parks for the purposes of perpetuating a timber supply in the Western States and Territories and for preserving forever the sources of their more important streams." Thus what is now proposed is not new either in principle or practice. There are a number of reasons that can be given why this should be a National Forest Reserve. First, the problems and dangers that it is intended to meet are National; second, this tract of land lies in several States and the streams that rise in them flow through many States and it would be difficult, even if possible, for these States to control and operate such a reserve successfully; third, these States are not so situated financially that they could even make the attempt to carry out this plan. Thus if the forest reserve, such as is contemplated, is established, it must be done by the National Government. The several States have conferred upon Congress the necessary authority to acquire land within their respective borders. These lands can at the present time be purchased at a very reasonable price; but they are increasing in value from year to year. While there are these fifty millions of acres in National Forest Reserves and Parks in the West, there is not a single National Forest Reserve in the East. (There are a few State Reserves).

The withdrawal of this large amount of land and putting it into the hands of the Government will not prevent the development of its other resources (mineral and agricultural) for these can be developed as fast as capital desires, but under the judicial guidance of the Government, and it is possible for large industries to become established in them.

Besides being a forest reservation, this tract of land will also be a large National Park, though this is a secondary consideration. It will be a National Park that will contain scenery of rare natural beauty and the highest mountains east of the Rocky Mountains, which are covered with trees and shrubs to their summits. The healthfulness of this region is already known throughout the country, and this and the climatic conditions are very favorable to a Park.

Resolutions Relating to Forest Reserve.—That the need of such a reserve as has been described above is appreciated by men of all stations, is shown by the many resolutions that have been passed, of which the following have been acted upon during the past year:

In March, 1906, a Forestry Congress was called at Charlotte, N. C., to which delegates were sent representing the States interested in the preservation of the Appalachian forests. Governor R. B. Glenn was chairman of this meeting. At this meeting on March 3d the following resolutions were passed:

"*Resolved*, That the governments of each of the States interested in the perpetuation of the Appalachian forests be urged to appoint a committee of three to arrange for organizing State forestry associations to secure National action in behalf of local forest developments, and the appointment of State foresters.

"*Second,* That the chairman of this meeting request the Governors of Virginia, West Virginia, Pennsylvania, Maryland, Tennessee, North and South Carolina, Georgia, Alabama, and each of the New England States, to coöperate with himself in appointing five delegates from each of these States to meet in Washington, at a date to be fixed by the chairman, to urge the passage of the bill now pending in Congress looking to the establishment and maintenance of forest reserves in the Appalachian and White mountains.

"*Third,* That the Senators and Representatives in Congress from the States adjacent to Appalachian regions be earnestly urged to do everything in their power to secure the passage of these bills."

Pursuant to the second resolution, Governor Glenn appointed Mr. Henry E. Fries of Winston-Salem, Mr. F. R. Hewitt of Asheville, of the Geological Survey Board, and the State Geologist, among the delegates to represent North Carolina at the meeting to be held in Washington. This delegation met the Agricultural Committee of the House on April 24 and 25, 1906. Governor Glenn presided over this delegation, and made a very strong and eloquent speech to the committee in favor of the formation of the Appalachian and White Mountain Forest Reserves.

At a meeting of the American Cotton Manufacturers' Association held at Asheville May 16, 1906, the following resolutions were passed:

"*Resolved,* That the members of this association urge upon their Representatives in Congress to give their earnest and lively support to the bill (Senate Bill No. 4953) now before Congress for the establishment of these forest reserves; and, further,

"*Resolved,* That it is the opinion of this association that the organization of State forestry associations, especially in those States containing forests of large economic importance, will be of material assistance in the preservation and perpetuation of a State's forests, and that such organizations should be made as rapidly as possible."

The State Geologist desires to call the attention of the General Assembly to the fact that the bill now before Congress for the establishment of the Appalachian and White Mountain Forest Reserves has passed the Senate and been favorably recommended by the House Committee on Agriculture, and would earnestly urge that the present Legislature adopt resolutions to be presented to the House of Representatives requesting that the bill be allowed to be brought up for discussion during the present session of Congress. In this connection the State Geologist has, with the American Forestry Association, obtained a memorial or petition to be sent to the members of the House of Representatives from the Southern Appalachian States, which will be signed by the Governors and other State officials and prominent professional and business men. The following is the resolution that is being signed:

To the Members of the House of Representatives from the Southern Appalachian States.

GENTLEMEN:—In regard to the bill now before the House of Representatives for the establishment of the two forest reserves in the East to be known as the Appalachian and White Mountain Forest Reserves, we, the undersigned, request your earnest efforts in its behalf, believing that the passage of this bill will be of infinite value to the various States in New England and the Southern Appalachians. We, therefore, desire your personal influence in securing its passage at this short session, as it has already passed the Senate and been unanimously recommended to the House by the Committee on Agriculture.

It is the opinion of those who have studied this question that a bill creating these forest reserves must ultimately be passed, and as any delayed action will necessarily increase the cost to the Government of the formation of these forest reserves, it is economy on the part of Congress to pass the present bill. The main reason, however, for immediate action is to prevent all the work hitherto accomplished from having to be done over, and to prevent further denudation of the mountain slopes, which, if not checked, will go on more rapidly, causing irreparable damage not only to the water-powers of the country both North and South, but also to farm lands, roads, railroads, etc.

We, therefore, request that you give this matter serious and immediate consideration, and individually and collectively bring this to the attention of the Speaker and support the bill on the floor of the House.

Very respectfully.

This request has already been signed by the Governors and other State officials of Alabama, Georgia, Maryland and North Carolina. A similar request has been signed by all the Governors of New England and other prominent men of those States.

STATE SWAMP LANDS.

Another line of work that has been taken up by the Survey has been an examination of portions of the swamp lands belonging to the State, and it has been thought that the report of this work, which was done by Mr. W. W. Ashe, should be published as a part of the present Biennial Report of the State Geologist.

REPORT ON AN EXAMINATION OF CERTAIN SWAMP LANDS BELONGING TO THE STATE.

BY W. W. ASHE, FORESTER.

An examination of the most promising portions of the swamp timber lands belonging to the State, and under the control of the North Carolina State Board of Education, has been made under the supervision of the United States Bureau of Forestry, at the request of the North Carolina Geological and Economic Survey, in order to ascertain the advisability of placing them under forest management and simply selling the trees, and also to determine the value of these lands and what portions it would be best to sell outright.

This land, which is held for the benefit of the public school fund of the State, embraces about 500,000 acres, all of which is situated in the Atlantic Coastal Plain region and within 80 miles of the coast.

It is not in any single body, but includes more than 15 different tracts from a few hundred acres to more than 110,000 acres in area.

The North Carolina Geological Survey, in consultation with Mr. J. Y. Joyner, Superintendent of Public Instruction, and Mr. Duckett, Chief Clerk to the Board of Education, decided upon three areas lying in different portions of the coastal plain, as the most promising, and these were examined. Since so much of the valuable timber is situated near the edges of the swamp, especially the larger ones, the examination was confined to those areas which had been surveyed, the boundary-lines of which were known at least in part, and where there were fewest counter-claims. The tracts chosen for examination were:

Angola Bay, in Pender and Duplin counties, embracing, exclusive of interior holdings, 44,000 acres.

Open grounds of Carteret County, with an area of 110,000 acres.

Newport Pocosin in Craven County, having an area of 8,000 acres.

The results of the examination of these tracts of timber lands are embodied in the following pages, each tract being taken up separately:

Angola Bay.—The Board of Education has recently had two offers to purchase this swamp, and its sale has been under consideration by the Board. For this reason it was considered advisable to examine it first. The Board also had a report upon the amount, condition, and location of the timber upon it made by an experienced pine-timber estimator, Mr. Sylvester Peel. This report, to which access was given, was found to be accurate on the points it considered, and proved of great service.

This swamp is situated about thirty miles north of Wilmington, N. C. The Northeast Cape Fear River flows for ten miles within a mile of the western limits of the Board's holdings. This river is open to steamboat navigation. Holly Shelter Creek, a tributary of Northeast River, which follows closely the southern and eastern boundaries for about fourteen miles, is large enough for rafting for ten miles during winter and spring. The Wilmington branch of the Atlantic Coast Line Railroad is from six to ten miles west of the swamp. This and the river furnish ample facilities for transportation. The swamp is ten miles long, northwest and southeast, and seven miles wide east and west.

The surface is nearly level. The highest point at the northwest corner is only about forty feet above mean tide-water level at Crooms' bridge on the Northeast River, and those portions along the southeast side of the swamp are only ten to fifteen feet above mean water level in the streams. There is a gradual and almost uniform fall of three to six feet to the mile. A chain of small sand ridges from one to three feet above the general level of the swamp extends from near the center of the swamp to the southeastern edge.

The soil of the entire State holdings, except such of the sandy ridges as have not been sold, is very uniform in character. It consists of either pure peat, formed from sphagnum or sphagnum-like mosses, or of a mixture of moss, peat, and other organic matter formed by the decay of leaves, twigs, and roots of ericaceous shrubs, leaves of bay trees, and a small amount of grass and pine leaves. Only around the edges of the swamp is there any considerable amount of inorganic material in the soil, and this consists almost entirely of fine sand. This peaty soil is from three to eleven feet deep and is underlaid by sand or sandy loams. When the proportion of sand becomes large, probably more than 30 per cent., and the land is so situated that it can be drained and sweetened, it makes fair farming land. Such land, however, is situated only around the margins of the swamp, and has largely passed into the possession of private owners. Lumps of soil, selected at different places in this swamp, and also from the other tracts examined, and air-dried for two weeks, gave, when moistened, an acid reaction on litmus paper. Their acidity is, undoubtedly, too great for the growth of staple crops or for the growth of most trees.

In spite of a rainfall of nearly sixty inches a year, the sponginess of the soils and their imperfect drainage, they become very dry and inflammable during dry seasons, in the spring as well as summer and fall. Places were noticed where holes three and four feet deep had been burned, some of them ten and twenty feet wide. When a fire occurs during a dry period it is seldom that the entire soil on the burned area is not consumed to a depth of from six inches to a foot or more. A fire which took place in September, 1904, burned over between three and four thousand acres. Of this more than one thousand acres was burned to an average depth of more than eighteen inches, and there were thousands of holes between knee and waist deep. On the other hand, on account of the poor drainage and sponginess the soil, during winter, and usually during spring, becomes extremely wet, and is often flooded to a depth of six inches or more, which makes walking very difficult or even impossible on account of the miring and bogginess. Around the edges of the swamp and bordering the larger streams, where the drainage is better, or where there is a large intermixture of sand, or the peaty deposit is not so deep, the soil is firmer and more compact. This condition is usually indicated by a growth of cane, and is favorable to the growth of pond pine.

The soil becomes less compact and the drainage poorer as the center of the swamp is approached. Near the center is an area of 2,000 or more acres, the soil of which trembles at each step. A public road was built through the swamp about twenty years ago. It was deeply ditched in each side to drain it, and these ditches likewise drain a narrow strip of land on each side of the road. It has no perceptible effect upon the growth of the pine timber contiguous to it, although an improved condition is marked by the cane which has appeared in small patches.

Timber.—The only tree of commercial importance on the three tracts examined is the pond pine. Intimately associated with it are the bays: the hull bay, which forms more than one-half of the arborescent and subarboreal growth other than the pine, the sweet or red bay, which is frequent, and the white bay, which occurs as single scattered specimens or forms nearly pure clumps from a few square feet to several acres in extent. The bays are vigorous sprouters and early seeders, and where fire is absent for a few years, form on most of the wetter soil, which is not too peaty, dense, almost impenetrable thickets. They grow rapidly in height, but have no commercial value, and would seriously interfere with an extension of the distribution of the pine, although in many places the pine seems to have no difficulty in holding its own.

Along some of the larger streams, which have cut channels to the sandy subsoil, are a few small cypress, the timber of which is inferior in quality, associated with small black-gum and red maple. The amount of such growth is insignificant and need not be considered.

There were reported to be a few acres of white cedar (juniper), but not a single specimen was seen on the Board of Education's land during this examination.

Distribution of Timber.—The merchantable timber is confined to a strip one-half to one mile wide on the west, south, and southeast sides of the tract, and lying immediately along the edge of the swamp. On portions of the southern edge and along the entire northern edge of swamp the adverse holdings extend far enough into the swamp to include all the merchantable timber. The farther the timber is situated from the edge of the swamp the poorer is its quality and the smaller its size. On the interior of the swamp the merchantable timber is confined to occasional clumps or groups of trees, often at great distances apart. The merchantable timber occupies between 6,000 and 7,000 acres. Peel estimates it at 18,000,000 feet board measure; evidently a liberal figure, on account of the large proportion of defective timber.

About two miles west of the center of the area is a treeless moor of 2,000 or 3,000 acres, covered only with a low growth of bitterbush, gallberry, cyrilla, and greenbrier. This growth forms the ground cover of the entire swamp, except on well-drained or firm-soiled areas, which are occupied by cane, and areas where it is crowded out by a dense growth of bays or a very heavy stand of pine.

Under the best conditions observed on any of the State lands where there is a firm, comparatively well-drained soil, this tree reached a height of 60 to 70 feet, and a diameter of 16 inches to 18 inches breast-high. Trees 12 inches in diameter breast-high, average about 90 years old. A thrifty young tree, growing under slightly better conditions than the average, had, at 58 years of age, a diameter of 8 inches breast-high and a height of 60 feet.

The pine in the interior of the swamp is very scrubby, seldom more than 25 to 30 feet in height, and rarely exceeding 10 inches in diameter. Trees 35 feet high and 10 inches in diameter breast-high, two miles in the interior, are more than 100 years old. It is possible that the fires, which occur from three to ten years apart, are partly responsible for this slow rate of growth, for the growth is irregular as well as slow, numerous bands of very slow growth alternating with much wider rings. While the rate of diameter growth is more rapid during the first two decades than subsequently, after that there seems to be but a slight decline in the rate, except when influenced by the irregular growth noted above. A large proportion of the trees above 12 inches in diameter are defective or unsound, either in the first or second log. This is indicated by large knot-holes or punk. A count showed fourteen unsound trees out of twenty-six trees, above 10 inches in diameter breast-high. While the conditions become very favorable for tree growth in the interior of the swamp, it is possible that if the fires could be checked, a far larger area might produce trees of merchantable size. Undoubtedly, a large number of these scrubby pines are stool sprouts from fire-killed saplings, and it is possible that all of the pines in the interior of the swamp may be such fire-sprouts. Many were probably killed back several times before they became large enough to escape injury.

Since no attempt was made to prepare a working plan for this tract, no count was made of the exact number of trees in the size classes, but notes were made at frequent and regular intervals of the number of saplings, poles, and standards to the acre, especially when it was evident that the soil was good and capable of producing timber large enough for saw-logs. The number of young trees from 8 to 12 inches in diameter breast-high on good soil is very large, probably twice the number of trees above 12 inches. The distribution of the size classes very irregular, on account of even-aged stands following fires and the great intolerance of the pond pine. While there is generally more or less young timber mixed with old stands, it is usually in clumps or groups of a few trees. There are sometimes large areas of approximately even-aged young timber which have come up after a fire. An area of saplings was noted 5 to 7 feet in height and from 300 to 500 to the acre extending for more than a mile.

There is an average of at least 12, and probably nearer 20 sound trees from 8 to 12 inches in diameter breast-high to the acre on the

6,000 acres capable of producing merchantable timber. The increase in diameter is slightly less than one inch during a decade. The poor diameter-growth, accompanied with the low height, results in very slight annual accretion. If placed at 50 feet, board measure, to the acre a year for the 6,000 acres of best quality, the rest of the tract regarded as non-productive, after the sale of the merchantable timber above 12 inches now standing, the tract would have a value, based on its earning power, of $12,000, or $2 per acre for the productive portion. This is on the basis of stumpage at $2 a thousand feet, board measure, the present price for this grade of timber, and neglects entirely taxes, from which this land is exempt. On account of the large portion of the tract which is waste land, the timber now mature will sell for almost, if not fully, as much as the land and timber together. If fire can be prevented during and immediately after lumbering, and the tract subsequently afforded protection from fire, the earning capacity of the tract and its value as an investment can be largely increased. If swept by a heavy fire while the dry tops are on the ground and the soil burned over the entire swamp, as it has already been burned in places, the entire earning power will be destroyed for a great many years.

Reproduction is excellent, 1 and 2-year-old seedlings are very common, not only immediately around seed-bearing trees, but on recent burns, at distances of 100 yards or more from seed trees.

The Open Ground of Carteret County.—The general condition of the tract is similar to that of Angola Bay. The topography is the same. The soils are peaty, and the interior is an open, treeless, peat bog, with only a growth of low ericaceous shrubs. Good timber occupies apparently not more than one-tenth of the 110,000 acres; scrubby pine growth on the inner edge of the peat bog covers perhaps 50,000 to 60,000 acres, while there are about 40,000 acres of open ground in the center of the tract. This estimate of the relative proportion of each is based on statements secured from surveyors and persons living near the land. A trip was also made through the tract at its longest part.

The pond pine is the only tree which has any commercial value, known to occur on the Board of Education's land, as the several bodies of white cedar and gum swamps are claimed by others.

The earning power of this tract, considering its large area, is very small. Stumpage has a lower value on account of the scattered character of the timber. Conditions are thus most unfavorable for profitable management.

Protection from fire will be extremely difficult unless the numerous adjoining properties, which form a narrow belt lying between the tract and the water-front, are acquired and managed in connection with it.

Newport Pocosin.—This is a small tract containing only 8,000 acres, and was reported by Peel to be "well timbered." The conditions are in nowise different from those of Angola Bay, as the soil is peaty and the pond pine the only tree of value. On account of the small area of this tract, the good timber around the margin forms a much larger proportion of the entire area. It is crossed at one end by the Atlantic and North Carolina Railroad.

This tract presents a good opportunity for the application of systematic management to the pond pine. The different-sized classes are well represented, and seedlings are abundant. It is frequently burned, but apparently not so severely as Angola Bay. The entire area was slightly burned this fall.

Holly Shelter Swamp has an area of 60,000 acres. It is situated near Angola Bay, and residents state that it had the same conditions as Angola Bay.

It should be mentioned here that a large part of the soil of these swamps is situated for the growth of white cedar. On account of fires, to which it is extremely sensitive, it could not be introduced unless they could be checked.

It should also be mentioned that there is a probable asset in these tracts in the hunting privilege, since they are all well stocked with deer and bear.

Recommendations.—It is believed that as the bulk of these swamp lands offer no inducements to management, their sale is advisable, provided they can be sold. By the exclusion of fire, by draining, and by planting cedar, large areas might be made productive eventually; but the great danger from fire, the cost of drainage, and the exceedingly doubtful character of the returns from such an investment make it impracticable at present. The case is different, however, as regards the areas timbered with pond pine. It is not a good policy to sell the lands at the prices now offered, which are often less than the stumpage value of the merchantable timber. These lands should be retained and the pond pine above 12 inches sold at $2 per thousand feet, board measure. Trees below 12 inches should be left, as they will furnish another crop in from 20 to 30 years. Fire should be excluded as far as possible, and in selling timber the contract should provide for this, as well as for the leaving of the smaller trees and their protection during lumbering.

Forestry Problems Along the Banks.—Problems of considerable interest have recently come up regarding the preservation of the small areas of forests that still remain on a few sections of the Banks, and of the reforestation of certain other sections. A definite plan of action is now being outlined in regard to these problems and the work will be taken up in coöperation with the United States Bureau of Forestry. This work has been under consideration for some time, and facts regarding the conditions existing along the Banks have been collected partly by Prof. Collier Cobb, in connection with his work on the Sand-Dunes and Reefs of Eastern North Carolina, and Mr. I. F. Lewis, of Johns Hopkins University, Baltimore, and Raleigh, N. C., who has spent two summers at work on the Banks near Beaufort, N. C. They have made some notes regarding the conditions as they were and now exist on Shackleford Banks, extending from Cape Lookout southwestward about eight miles, to Beaufort Inlet, which are embodied in the following paragraphs:

Shackleford Bank extends from Cape Lookout southwestward about eight miles to Beaufort Inlet, and is from a half to three-quarters of a mile broad. The whole Bank was, within the memory of the older inhabitants, heavily wooded over its entire area. Owing, however, to cutting of the timber for firewood and lumber, the sand of the beach began to drift in on the forest somewhere near 1840. At this time the beach was higher than the forest on the sound side. The beach is described by Mr. Torrey Moore, an inhabitant of the Bank since 1828, as "flattening out on the woods," and so killing the trees. At the present date the eastern end of the Bank is completely "sanded over." The original forest is represented only by several clumps or "islands" of live-oak, which happened to be hardy enough to withstand the drifting sand. Near the western end of the Bank, about two miles of this forest land still remains, though it is rapidly being encroached upon by the advancing sand. Along the seaward side of this strip the beach, originally narrow, has broadened to a quarter of a mile or more, destroying the forest as the sand moved toward the sound. The sand is encroaching on the forest with greater rapidity as the increased breadth of the beach gives more surface for the wind to take up the dry particles and blow them over on the forest.

The forest here is made up chiefly of live-oak and red cedar, with the red mulberry, holly, water beech (Carpinus), and red bay (Persea) occurring commonly. The trees are not large, but are densely massed, and serve to prevent the winter storms from sweeping over the Bank. Cutting of timber was once a common practice, but is no longer so, for the reason that the islanders realize that their only protection from storms lies in the forests themselves. The trees are still sometimes used for firewood by the natives.

The inhabitants of the island live on the side of the Bank near the sound, and make their living partly by fishing and partly by gardening. The soil is a deep and mellow loam, suitable for most vegetables grown in this country. The principal plants now under cultivation are figs, tomatoes, sweet and Irish potatoes, cabbage, turnips, beans, peas, watermelons and cantaloupes. If the drifting sand is allowed to advance much farther toward the sound, these gardens must be abandoned and the living of the inhabitants must become very precarious.

In the woods on the western end of Shackleford are a considerable number of ponies, cattle, sheep and goats. Sheriff Hancock of Carteret County estimates the numbers from Cape Lookout west as follows: Three hundred ponies, 500 sheep, 250 cattle, 300 goats. Of course, the existence of this live-stock depends on the preservation of the forests.

A more important, though less immediate, reason for checking the sand drift lies in its effect on the channels and fisheries of the sounds. Where the once wooded Bank has become a sandy desert, the sand blown by the wind has filled in or is filling in the channel of Core Sound. Wherever the woods are still in existence, the deep water extends up to the Bank, but where the woods have been exterminated, the channel near the Bank has filled up, being now only one or two feet deep at low water. This in itself is not of great importance for navigation so long as other channels near the mainland can be kept open. However, as the sand drifts in, these will gradually become shallower until, probably within the course of a few decades, the waterway between Bogue and Pamlico sounds will become closed. The effect of a filling in of the channels would be disastrous to the fishing industry at this point. The enormous stream of mullet and other fish now coming through Core Sound from Pamlico would be diverted to some other outlet, and fishing would cease to be a means of existence to the people of the region.

As an example of the effect on the people of the drifting sand, attention is called to Diamond City, a fishing village on the sound side of Shackleford Bank not far from Cape Lookout. When the forest covered this part of the Bank the villagers were prosperous, being sure of a good catch of fish and having productive gardens under cultivation. As the sand came over from the beach, the gardens were first destroyed, then the channels began filling in and the catch of fish fell off. Finally, as the sand spread out more and more, the winter storms began to sweep the Bank more and more completely, until, about 1903, conditions became such that the settlement was broken up, and the inhabitants, about four hundred in all, were compelled to move over to Harker's Island, near the mainland. Now Diamond City is visited only in the fall, when fishermen take up temporary quarters during part of the fishing season.

There is one element of the situation which, so far as is known, is different from the conditions where sandbinding work has been instituted, as, for instance, Cape Cod. The winds which cause the sands to move are from the south, blowing pretty constantly during the spring and summer, or growing season. The stronger northeast winds of winter have little effect on the sand. What effect they have consists in blowing the sand back towards the ocean. They are less effective as sand movers than the south winds of summer, partly because they blow less constantly and partly because their force is greatest when the sand is wet from winter rains and not easily to be moved. At any rate, the sand is moving north, carried so chiefly in the summer months, whereas at other points where conditions have been studied, it moves south and west, being blown by winter winds. This condition, which probably obtains along the South Atlantic and Gulf coast, causes the problem to be presented in a slightly different aspect from that usually considered, and serves to emphasize the desirability of experimental work at this point.

Early in January a preliminary survey will be made by one of the foresters of the United States Bureau of Forestry, and then a plan of work covering several seasons so as to insure the permanency of the results will be inaugurated by the North Carolina Geological and Economic Survey and the United States Bureau of Forestry. The plan will include not only the protection of the forests and farm lands already present, but also the reforestation of the barren portions. The results will be extremely valuable both from a practical and scientific point of view.

In order to carry on the forestry work efficiently and to accomplish the desired results, I would recommend a special appropriation of at least $3,000, to pay the salary and expenses of a forester, who would take charge of all the work relating to forestry.

MAGNETIC SURVEY.

In March, 1898, a magnetic survey was begun in North Carolina under the joint auspices of the United States Coast and Geodetic Survey and the North Carolina Geological Survey. The plan of work was the establishment of a true north and south line and the determination of the magnetic declination, dip and horizontal intensity, at every county-seat in the State. This work was continued until this was accomplished. In order to determine the changes in the declination the stations are now being re-occupied, and during the past two years eight stations have been re-occupied. One new station was established at Raleigh on the land of the Experiment Farm about two miles from the center of the city. It is 72.1 feet from the nearest corner of the house occupied by Mr. Jeffreys and 111.5 feet from the nearest corner of a vacant house to the southwest. It is marked by a post of Georgia marble 6 inches square. The following true bearings were determined:

From northeast edge of cross on Catholic church	1° 21.3	west of south.
From spire on glass turret of hospital	32° 46.7	east of south.
From southeast corner of Agricultural College	42° 01.7	east of south.

The following magnetic observations were made during 1905 and 1906, and there is also given the earlier observations at these same points:

MAGNETIC OBSERVATIONS AT NORTH CAROLINA STATIONS.

Place.	County.	Date.	Declination West.		Observer.
			Degrees.	Minutes.	
Wadesboro	Anson	Jan. 6, 1904	0	11.7	F. M. Little.
Wadesboro	Anson	Oct. 21, 1904	0	8.5	F. M. Little.
Salisbury	Rowan	April 21, 1905	0	34.	W. H. Burger.
Halifax	Halifax	July 19, 1906	2	19.7	F. W. Reed.
New Bern	Craven	July 25, 1906	3	13.6	F. W. Reed.
Southport	Brunswick	July 27, 1906	2	14.	F. W. Reed.
Raleigh (Old Station)	Wake	Aug. 1, 1906	2	54.2	F. W. Reed.
Raleigh (New Station)	Wake	Aug. 2, 1906	2	21.8	F. W. Reed.
Chapel Hill	Orange	Aug. 6, 1906	1	54.	F. W. Reed.
Morganton	Burke	Aug. 8-10, 1906	0	38.9	F. W. Reed.

EARLIER OBSERVATIONS AT NORTH CAROLINA STATIONS.

Place.	County.	Date.	Declination West.		Observer.
			Degrees.	Minutes.	
Halifax	Halifax	April 29, 1899	2	0	J. D. Baylor.
New Bern	Craven	July 9, 1898	2	46.6	J. D. Baylor.
Southport	Brunswick	Aug. 5, 1898	1	50.4	J. D. Baylor.
Raleigh (Old)	Wake	June 10, 1899	2	27.1	J. D. Baylor.
Chapel Hill	Orange	Mch. 25, 1898	1	28.6	J. D. Baylor.
Morganton	Burke	Sept. 3, 1900	0	27.7	J. D. Baylor.

A complete list of declinations in North Carolina as observed at the county-seats are given in the report of the United States Coast and Geodetic Survey for 1898-1899 in a separate known as Appendix No. 9.

The following directions to surveyors concerning the use of the county meridian lines either for determining magnetic declination or for ascertaining the index errors of their instruments are given by the United States Coast and Geodetic Survey and should be carefully followed:

"If the instrument used be mounted on a tripod, it should be carefully centered and leveled over the cross on top of the same monument—the 'reference' monument—over which observations were made in the magnetic survey and described in the descriptions of stations as published in this report. The monument to be sighted on is termed the 'range' monument.

"Should the instrument used be mounted on a simple Jacob's staff, it can be placed in the meridian line as close to the 'reference' monument as possible and leveled.

"A small rod should then be held in a vertical position over the cross in the top of the other monument—the 'range' monument. The compass needle is released and magnetic bearing of the small rod read. This should be done with a small non-magnetic magnifying glass, and it should be repeated about ten times, disturbing the needle with a bit of iron and letting it come to rest before each reading. The mean of all these bearings should be taken as the magnetic declination west or east, as the case may be.

"In order to obtain the mean declination for the day (24 hours) these results should be obtained between 10:00 and 10:30 A. M., or about 6:00 P. M., local mean time. (See Table I of report referred to). The local mean time is obtained by subtracting from the railroad time four minutes for every degree of longitude the surveyor is west of the seventy-fifth meridian of longitude. No observations should be made during times of violent changes of the pointing of the magnetic needle, as, *e. g.*, during magnetic storms.

"Should the resulting declination differ essentially from the declination as obtained from the published value in the report referred to, it proves conclusively that the surveyor's instrument has an error, which should be gotten rid of as nearly as possible by putting the instrument and needle in good adjustment. Any difference still remaining after the surveyor has satisfied himself that his instrument is in first-class condition and in good adjustment should be duly allowed for and recorded by the surveyor."

FISHING INDUSTRIES.

During the past two years a great deal of work has been done by the Survey in connection with the fishing industries of the State, and in this work we have had the hearty coöperation of the United States Bureau of Fisheries. Special investigations have been made regarding the shad and herring fishing industries; and the cultivation of the oyster, clam and terrapin. These investigations have shown that it is absolutely necessary that the State take some measures to protect its fishing industries of all kinds in order to prevent the total extermination of certain of these fish and the destruction of certain fishing industries that are of very great value to the State. In consequence of these investigations, at the suggestion of the State Geologist, the Governor, as chairman of the Geological and Economic Survey Board, appointed a committee of representative men of eastern North Carolina, which met at Morehead City during September and took up a thorough discussion of the situation, and suggested certain measures which they believe will insure protection of our fishing industries and prevent the extermination of any of our fish or a decrease in any of the fishing industries. This committee also suggested such legislation as in their opinion would result in the commercial cultivation of the oyster, clam and terrapin. The deliberations of this committee have been published as Economic Paper No. 13. The State Geologist would call especial attention to the suggestions of this committee regarding the organization of a Fish Commission and a Shell-fish Commission for North Carolina as given on pages 14 and 44 of the report; to general legislation as recommended on pages 39 to 42, particularly as it refers to Early Closing Season for Shad and Herring; to the general laws regarding terrapin given on page 43; and to the cultivation of the oyster and clam as given on pages 67 to 71.

If the General Assembly will provide for a Fish Commission for North Carolina and give this Commission the authority to enforce all laws relating to the fishing industry, it will have taken a long step forward in the protection and perpetuation of the State's fishing industries. The products of the waters of the State belong to the State and not to the individual, and, therefore, the State has a right and should exercise this right to prevent the wholesale or total destruction of industries that are of great value; and of the total elimination of certain fishes within its waters by restricting at all places the fishing season and limiting, as far as possible, the amount of apparatus fished. While such restrictions may, for the time being, prove a hardship for a few individuals, yet in the end it will mean a large increase in the fishing industries, and will, therefore, mean a larger revenue to the individual and through him to the State.

Investigations have been carried on during the past two years by Messrs. R. E. Coker, Biologist of the Survey, and H. D. Aller, of the U. S. Bureau of Fisheries, on oyster culture in North Carolina. The results of these investigations have shown that the cultivation of the oyster in many of the waters of eastern North Carolina is practicable and profitable. One report has already been published on this subject and the text for another is now being edited.

Investigations have been carried on by Dr. R. E. Coker on the natural history and cultivation of the diamond-back terrapin, and the results have been published in a report known as Bulletin No. 14. This work was also done in coöperation with the United States Bureau of Fisheries. The condition of the shad and herring industries was investigated by Mr. John N. Cobb, of the United States Bureau of Fisheries, and the results of the investigation have been published in Economic Paper No. 12. In connection with this work, a series of maps were prepared of Pamlico and Albemarle sounds and tributaries, together with the Cape Fear River districts, showing the location of all nets used in fishing for shad and herring during 1906. As these maps were prepared from the latest charts of the United States Coast and Geodetic Survey, they will make very useful base maps for further work in regard to the various fishing industries of the State.

Another work that has been finished during the past year which will be of value and interest to all North Carolina is a volume on the Fishes of North Carolina. This volume is now in press and should be ready for distribution within the next two months. It gives a detailed description of every fish that has been found in North Carolina, and in most cases figures are given of each. This work has been done for the Survey by Dr. H. M. Smith of the U. S. Bureau of Fisheries.

PUBLICATIONS.

During 1905 and 1906 the following publications have been issued by the North Carolina Geological and Economic Survey which embody the results of the investigations briefly outlined above, and to which references have been made:

VOLUMES.

No. 1. Corundum and the Peridotites of Western North Carolina and other economic minerals associated with these rocks, by Joseph Hyde Pratt and Joseph Volney Lewis, 464 pages, 45 plates.

BULLETINS.

No. 2. Building and Ornamental Stones of North Carolina, by T. L. Watson and F. B. Laney in collaboration with Dr. George P. Merrill. 283 pages, 22 plates.

No. 14. On the Natural History and Cultivation of the Diamond-back Terrapin, by R. E. Coker, 70 pages and 23 plates.

ECONOMIC PAPERS.

No. 9. Mining Industry of North Carolina During 1904, by Joseph Hyde Pratt, 95 pages.

No. 10. Oyster Culture in North Carolina, by R. E. Coker, 39 pages.

No. 11. Mining Industry in North Carolina During 1905, by Joseph Hyde Pratt, — pages.

No. 12. Investigations Relative to the Shad Fisheries of North Carolina, by John N. Cobb, 42 pages, 7 plates.

No. 13. Report of Committee Appointed by Governor R. B. Glenn to Investigate the Fishing Industries in North Carolina, compiled by Joseph Hyde Pratt, 75 pages.

GOOD ROADS CIRCULARS.

Eleven of these circulars have been issued during the past two years and distributed throughout the State. They have taken up all sorts of questions pertinent to the subject of good roads. Some of these have laid special emphasis on the issuing of bonds for the construction of good roads. Circular No. 40 took up especially the relation of public roads to immigration.

The following reports are now in press and should be ready for distribution by March 1, 1907:

VOLUMES.

No. 11. Fish and Fisheries of North Carolina, by H. M. Smith, a volume of about 500 pages.

BULLETINS.

No. 15. Gems and Precious Stones of North Carolina, by George F. Kunz, about 11 pages.

The following reports are in preparation:

VOLUMES.

Mineral Resources of North Carolina, by Joseph Hyde Pratt. This will make a volume of about 400 to 450 pages.
Mica and the Pegmatites of North Carolina, by Joseph Hyde Pratt and D. B. Sterrett.
The Cretaceous Formations of North Carolina, by E. W. Berry.

BULLETINS.

Mineral Waters of North Carolina, by F. P. Venable and Joseph Hyde Pratt.
The Copper Deposits of North Carolina, by Joseph Hyde Pratt and F. B. Laney.
The Loblolly Pine in Eastern North Carolina, by W. W. Ashe.
Shade Trees of North Carolina, by W. W. Ashe.
Artesian Water Supply in North Carolina, by L. S. Stephenson and E. W. Berry.
Sand Dunes and Reefs of North Carolina, by Collier Cobb.

ECONOMIC PAPERS.

Low Grade Gold Ores of North Carolina, by A. A. Steel.
Mining Industry in North Carolina for 1906, by Joseph Hyde Pratt.

CO-OPERATIVE WORK WITH U. S. GOVERNMENT SURVEYS AND BUREAUS.

Under section 9 of the act creating the Geological and Economic Survey, the State Geologist, with the approval of the Geological Board, is authorized to arrange for and accept such aid and coöperation from the several United States Government Bureaus and other sources as may assist in completing the topographic surveys of the State and in carrying out other provisions of this act.

Under this section, coöperative work has been carried on with the United States Bureau of Fisheries in connection with the investigations relating to fin-fish and shell-fish industries of the State. They have been most liberal in their coöperation with us, realizing that the work that is being done by the Geological and Economic Survey is of the utmost importance to the State and is also of great importance to the general fishing industries of the United States. They have also signified their willingness to coöperate with us during the coming two years along similar lines as during the past two years. This will mean that the State will be able to carry on these investigations relating to the cultivation of the oyster and clam which it would be almost impossible for it to do without this coöperation, on account of the very large expense. This work will be of inestimable assistance to the Fish and Shell-fish Commissioners in their investigations relating to the fishing industries.

The coöperative work with the United States Geological Survey has been of very large value to the State, and has included topographic work and investigations relating to the mica deposits, the black sand investigations, general investigations relating to geology and the investigations of the artesian water supplies.

The Division of Public Roads of the U. S. Department of Agriculture has coöperated with the State Survey in obtaining statistics relating to the public roads of North Carolina, and has coöperated with several of the counties in the construction of sand-clay roads.

The Bureau of Forestry of the U. S. Department of Agriculture has also coöperated with the State Survey in connection with its examination of some of the swamp lands belonging to the State in eastern North Carolina, and in its investigations relating to the Appalachian Forest Reserve. It is now coöperating with the State Survey in the investigation of the banks of eastern North Carolina.

The United States Coast and Geodetic Survey is now re-occupying many of the meridian stations established in the counties of this State, and will continue this coöperation until all have been re-occupied.

The Geological and Economic Survey has also coöperated with several companies and individuals within the State in furnishing to them members of the Geological Survey staff for making special geological examinations of particular tracts of land. In most cases the cost of this work has been borne largely by the company or individual, the Geological Survey having the privilege of using all data and information collected by its men in any of its reports.

OFFICE WORK.

The office work of the Survey has been carried on by the State Geologist, assisted by Mr. F. B. Laney, Assistant Geologist; Miss H. M. Berry, Clerk and Stenographer, with Mr. R. H. Sykes, Miss Caro Gray and Mr. John Berry as temporary assistants. A considerable portion of the office work of the State Geologist has been the editing of the reports referred to above and the correction of the proof of these as they were going through the press. The correspondence requires a great deal of time of the State Geologist and his assistants, and letters are constantly being received requesting information regarding the localities of different minerals, statistics regarding their production, the value of mineral properties, methods for developing and mining the same, markets for mineral products; information regarding water-powers, artesian wells and mineral waters; information regarding forests, available tracts of forest lands, different varieties of timber, etc.; the construction of public roads and localities for obtaining materials for road construction; the oyster and fish industries, etc. During the past two years approximately six thousand letters have been written at the Survey office besides the circular-letters that have been sent out asking for and giving general information regarding certain subjects.

The value of the work of the Geological and Economic Survey is perhaps best illustrated in the enormous correspondence that is received at the office asking for information regarding all the subjects that have been mentioned above and which can be satisfactorily answered on account of the investigations that have been made. This has resulted in bringing into the State a great deal of capital for the development of the natural resources of the State, and it has also been the means of bringing many people into the State who have become permanent citizens.

The following statement will show the receipts and expenditures of the Geological and Economic Survey for the two years ending November 30, 1906, grouped according to the subjects investigated during this time. These are arranged separately for each of the two years.